



356063

QUALITY ASSURANCE PROJECT PLAN
PRE-DESIGN PHASE
WAUKEGAN HARBOR SITE
WAUKEGAN, ILLINOIS

Project Manager _____ Date _____

Quality Assurance Officer _____ Date _____

EPA Remedial Project Manager _____ Date _____

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2	N/A	Field Data Collection and Validation
3	86-059-B71	Laboratory Sample and Data Flow Chart
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QUALITY ASSURANCE PROJECT PLAN
PRE-DESIGN PHASE
WAUKEGAN HARBOR SITE
WAUKEGAN, ILLINOIS

1.0 PROJECT DESCRIPTION

1.1 Introduction

The purpose of the Quality Assurance Project Plan (QAPP) for the pre-design phase of the work (in the Work Plan), Appendix V to the Consent Decree, for the Waukegan Harbor Site (Site) in Waukegan, Illinois is to set forth the prime responsibilities and prescribe the necessary procedures required to assure that the project is executed in a manner consistent with the National Oil and Hazardous Substance Contingency Plan and with generally accepted and approved quality assurance objectives, that data generated is precise, accurate, representative, comparable, and complete, and that remedial action measures, specified in the work plan, will be completed as specified.

This QAPP provides guidance and specifications to assure that:

1. All field determinations and results regarding sampling and analysis are valid through the implementation of preventive maintenance, equipment calibration, and approved analytical protocols;
2. Sampling is conducted using sample tracking systems and chain-of-custody procedures which properly identify samples being collected and control those samples from field collection through analysis and data reduction;
3. Records are produced and retained as documentary evidence of the quality of samples collected and analyzed, the validity of applied procedures, and the completeness of the work performed;

4. Generated data is validated and appropriately used in calculations;
5. Calculations, evaluations, and decisions completed or deduced during the execution of the pre-design phase are accurate, appropriate, and consistent with the objectives of this Plan;
6. Construction activities are completed to the specifications described within this Plan.

The requirements of this QAPP are applicable to the pre-design activities of all participants in the remedial action at the Waukegan Harbor site in Waukegan, Illinois. This QAPP will address all anticipated activities necessary to execute the Work Plan pre-design activities as approved by the U.S. EPA.

1.2 Project Summary: Waukegan Harbor Site

1.2.1 Project Background

The Waukegan Harbor Site (Site) is located near the intersection of Grand Avenue and Sheridan Road on the west shore of Lake Michigan in Waukegan, Illinois, about 37 miles north of Chicago and 10 miles south of the Wisconsin state border.

The presence of high levels of PCBs in soil and harbor sediments in the vicinity of the OMC plant was discovered in 1976. From approximately 1961 to 1972, OMC purchased a hydraulic fluid used in the die-casting works that contained PCBs. Some of the PCBs purchased may have escaped through floor drains. The floor drains discharged to an oil interceptor system which discharged to the North Ditch. Some of these PCBs escaped from a portion of the oil interceptor, diversion and pump system, and were released to the

Waukegan Harbor. The harbor area discharge was located in the western end of Slip No. 3, and the north property discharge was in the Crescent Ditch. This discharge pipe to the harbor was sealed in 1976.

1.2.2 Project Objectives

The objectives of this QAPP are to assure proper field and laboratory procedures are employed in implementation of the pre-design investigation set forth in the Work Plan.

1.2.3 Major Task Summary

1.2.3.1 Pre-Design Work Plan

Major activities to be undertaken during the course of the pre-design phase of the Work Plan and addressed by this QAPP include the following:

1. Soil sample collection and physical analysis;
2. Installation of piezometers in the Silurian bedrock;
3. Surveying of site features, including the location and elevation of soil samples, ground water monitoring wells, sediment sampling locations, topographic contours of the ground surface, and piezometric contours of the ground water surface.

1.2.4 Reports

Quarterly status/progress reports will be prepared and submitted to U.S. EPA which summarize the results of all sampling and/or tests and present all other data generated during the preceeding quarter. Work Plan activities will be reviewed and the status of pending or completed activities

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will be indicated. Analytical and/or other documentation which support the summaries presented in the quarterly reports will be available and furnished to the U.S. EPA upon request.

Periodically, interim technical reports may be prepared to collate data and summarize the progress of the Work Plan, present conclusions affecting the scope or direction of continuing Work Plan activities. These reports will be scheduled and identified in the quarterly status/progress reports.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Organization

Quality assurance and control activities must occur at all levels of the organization in order to consistently produce effective and correct efficient solutions to a broad range of technical problems. The activities of the QAPP Team for the Work Plan must remain independent of the activities of the project task force in order to assure that procedures and protocols outlined in the Work Plan are carried out in a manner consistent with U.S. EPA guidelines.

2.2 Responsibility for Quality Assurance/Quality Control

Responsibility for quality assurance and quality control depends upon the project organization assembled to execute the work and on the maintenance of the principle lines of communication between members of the organization. Figure 1 shows the proposed task force for the implementation of the Work Plan and the lines of communication between various key individuals. The responsibilities of the Canonic task force and related managerial departments are summarized below.

2.2.1 Project Manager

The project manager is responsible for maintaining a clear definition of and adherence to the scope, schedule, and budget of the project. As a part of this responsibility, he will:

1. Serve as the on-site communication link with the U.S. EPA;

2. Provide immediate direction to staff involved in the completion of tasks outlined in the Work Plan;
3. Supervise all work by Canonie and its subcontractors;
4. Maintain budgetary and schedule surveillance of the work and regularly advise the Technical Project Director of the progress of the Work Plan.

2.2.2 Technical Project Director

The technical project director is responsible for the staffing and overall administration of the project. As part of his QA/QC responsibilities, he will:

1. Maintain the QAPP;
2. Indicate the types of QA/QC records to be retained as a permanent part of the project file;
3. Provide for QA/QC audits of the work of task force members;
4. Approve reports and material for release to the U.S. EPA and IEPA, and other external organizations;
5. Approve task plans and operating procedures related to the project.

2.2.3 Project Engineer/Project Scientist

The project engineer is responsible for the implementation of the Work Plan field activities, initial data acquisition, health and safety aspects of

field activities, and for the proper selection and execution of procedures which have been accepted for use in the Work Plan. As part of his QA/QC responsibilities, he will:

1. Provide personal direction of technicians or subcontractors executing Work Plan data gathering tasks and performing construction activities;
2. Review the effectiveness of procedures and suggest changes which will enhance or more efficiently accomplish the objectives of the Work Plan;
3. Assist in the collection of samples so that sampling remains representative of actual field conditions;
4. Assist in the maintenance of budgetary and scheduling surveillance;
5. Administer the regular maintenance of equipment utilized in the Work Plan to prevent unnecessary equipment failures and project delays caused thereby.
6. Assist in the preparation of reports, submittals, and presentations to assure that data and conclusions accurately reflect observed conditions in the field;

2.2.4 Task Leaders

The task leaders within the project task force are responsible for specific engineering, scientific, and analytical operations required to accomplish identified project objectives. As part of this responsibility, task leaders will:

1. Initiate, develop, and check subtask plans, procedures, support services and products;
2. Identify safety hazards and ensure that the associated risks are reduced to acceptable levels;
3. Supervise and participate in operations, analyses, data collection, and data reduction;
4. Maintain samples, sample identification, and analytical equipment;
5. Generate required QA/QC records and reports;
6. Implement corrective actions identified by QA/QC reports.

2.2.5 Quality Review Team

The Quality Review Team reports directly to the corporate officer in charge. The team is responsible for on-going surveillance of project activities to ensure conformance to this Plan and to evaluate the effectiveness of its requirements. The team has access to any Canonie personnel or project subcontractors, as necessary, to resolve quality assurance/quality control problems. The team has authority to recommend that work be stopped when the manner in which that work is being conducted appears to jeopardize project quality. As part of this responsibility, the team will:

1. Monitor the correction of quality control problems, and alert other task leaders where similar problems may exist or might occur;

2. Report to the corporate officer in charge concerning the quality of the work, the procedures utilized, and the services provided in relation to the stated objectives of the project;
3. Provide for retention of QA/QC records;
4. Participate in QA/QC audits;
5. Recommend changes, where appropriate, to improve the effectiveness of project procedures or the procedures identified in this Plan;
6. Review proposed additions and/or changes to this Plan.

The Quality Review Team is directed by the Quality Assurance Coordinator, who is responsible for evaluating and approving this Plan; scheduling and conducting quality assurance/quality control audits; providing QA/QC reports to the corporate officer in charge, the project manager, and the technical project director on the results of audits by the Quality Assurance Team and the necessity of preventive or corrective actions; and developing and initiating preventative and corrective actions, as required, in conjunction with the project manager and technical project director.

2.2.6 Support Departments

Canonie's accounting department will be responsible for the financial administration of subcontracts, the control of the payment of invoices, and for overall budgetary matters.

Canonie's technical support department will provide services in the areas of graphics, reproductions, word processing, data processing, and staffing. Canonie's soils laboratory will be the soils testing laboratory for the soil samples obtained during the pre-design work.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 General

The quality of measurements made and data acquired during the Work Plan process will be determined by the following characteristics: accuracy, precision, representativeness, completeness, and comparability. Specific objectives for each characteristic are established to develop sampling protocols and identify applicable documentation, sample handling procedures, and measurement system procedures. These objectives are established based on site conditions, objectives of the project, and knowledge of available measurement systems. The subsequent use of these measurements in calculations and evaluations is also subject to aspects of this Plan as described in the following sections.

Canonie will collect all soil samples and direct all field measurements in completing the work presented in the Work Plan. Sample collection and field handling will be in accordance with the sampling and sample handling protocols established in this Plan. All soil samples will be analyzed at Canonie's soils laboratory, located in Porter, Indiana. The quality assurance program developed for and utilized at Canonie's analytical laboratory is presented in Appendix A.

3.2 Representativeness

Measurements will be made so that analytical results are as representative of the actual field conditions as possible. Sampling protocols will be utilized to assure that samples collected are representative of the media present in the field. Sample handling protocols, including such tasks as storage, transportation, and preservation, will be used to protect the representativeness of the samples gathered during the project. Proper

documentation in the field and the laboratory will establish that protocols have been followed and that sample identification as well as integrity have been preserved.

The field sampling program, presented in the Work Plan, describes the samples which are currently planned for collection, the location of the sampling, the types of samples to be collected, and the types and number of analyses to be performed on the samples.

3.3 Precision and Accuracy

Precision is the characteristic which reflects the ability to replicate a previously obtained value using identical testing procedures, while accuracy is the characteristic which reflects the ability to obtain a value which equals, or approaches within certain predetermined limits, the true value of a certain phenomenon. Each of these two characteristics are addressed in all data gathering and reporting conducted by Canonie. Data quality objectives for precision and accuracy are established for each major parameter to be measured during the project. These objectives are based upon prior experience in executing remedial activities for wastes similar to those present or anticipated at this site, on prior knowledge of the capabilities of the measurement system to be employed during activity at the site, and on the limitations which are presented in execution of the task. The precision and accuracy requirements for certain data gathering and reporting activities may vary based upon the anticipated use of the information. For example, the precision and accuracy requirements of data gathered during surveying to locate ground water monitoring wells will not be as strict as the requirements imposed on analytical data, which is used to establish whether treated ground water is clean enough to discharge.

In general, the precision and accuracy requirements for the Work Plan program will be met by assuring that at least ten percent of the samples

gathered for analytical evaluation in each matrix type (i.e., soil, water, etc.) during each sampling episode are duplicates, so that field precision may be evaluated. Since standard sampling procedures are stipulated for all sampling episodes, no additional duplicates are required due to changes in sampling team composition. In the laboratory, ten percent of the samples of each matrix will be analyzed as replicates to evaluate laboratory precision. Duplicate and replicate samples will be chosen at random, unless the criticalness of the sampling would suggest duplicate sampling or replicate sampling to be appropriate.

Calculations performed with the data gathered or generated during the project are also checked for accuracy by the task leader or his designee, and precision, i.e., the comparability of calculation techniques between various tasks, is assured through review by the quality assurance team.

Accuracy of field measured pH will be evaluated through comparison of instrument readings taken on standard buffer solutions. Accuracy will be established by obtaining readings which do not vary from the standardized solution value by ± 0.05 pH units. Field measurements will be recorded to the nearest 0.05 pH units.

Accuracy of the field conductivity meter will be assured by daily calibration verification with a standardized solution of potassium chloride, purchased from the manufacturer of the meter or from a laboratory chemical supply house. If instrument readings vary from the standardized value by more than five percent (5%), the conductivity meter will be recalibrated or replaced.

Instruments which are factory calibrated will be considered accurate if the most recent calibration occurred within the previous 12-month period and the instrument readings do not appear to be in obvious error. Measurement

precision for all field instrumentation will be estimated by periodically (1 per 10 samples) completing duplicate testing of samples in the field.

3.4 Completeness

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was specified to be obtained under normal conditions. The amount of valid data specified is established based on the measurements required to accomplish project objectives. The extent of completeness must be reviewed on a relative basis for sample collection activities, since the required amount of valid data anticipated prior to sampling episodes may not accurately define the amount of data necessary to render a correct decision. Completeness of data handling systems is described in Sections 9, 12, and 13.

3.5 Comparability

The characteristic of comparability reflects both internal consistency of data collected with regard to a single parameter and an expression of data in units which are consistent with the units which data, gathered by other organizations measuring the same parameter, are presented. Comparability of data gathering and measuring procedures should also be addressed if data gathered is to be reliably compared. Thus, the characteristic of comparability implies the personnel involved in data acquisition and reduction must operate measurement systems within the calibrated range of the particular instrument as well as utilize analytical methodologies which produce comparable results.

When comparison of data sets indicates certain values within one or more sets are not consistent with the totality of the data acquired, these values, known as "outliers", must be reassessed prior to utilization in the decision-making process. Utilization of statistical analysis is often

required to define whether the "outliers" represent significant values which require recognition in the decision-making process.

3.6 Quality Assurance/Quality Control Objectives

The QA/QC objectives for the pre-design investigations are:

1. To collect soil samples that are representative of the soil types present at the site;
2. To determine the variation in the in-situ coefficient of permeability of natural impermeable formations with depth;
3. To collect, document, and prepare data for the final design activities that is accurate and reflects the variations likely in geologic materials.

4.0 PRE-DESIGN PROGRAM

4.1 Field Sampling Program

4.1.1 Introduction

The specific tasks that comprise the Field Sampling Program and the steps to execute the tasks are described in Section 2.0 of the Work Plan. The purpose of this section is to define the minimum standards for performing the field activities of the Pre-Design Program.

All drilling, soil sampling, and piezometer construction activities will be supervised by a qualified engineering or geologist. The engineer/geologist will summarize, daily on a field activity log, the progress made towards completing the activities in the Field Sampling Program. Also, any procedures or materials that are not in compliance with the Work Plan or QAPP will be documented and the corrective action taken will be noted. A daily field activity log is included in Appendix B.

4.1.2 Soil Sampling

4.1.2.1 Standard Split-Spoon Samples

Standard split-spoon samples will be taken in accordance with the requirements of ASTM D-1586. A copy of the procedures is attached in Appendix C. The split-spoon may be driven a total of 24 inches at the discretion of the field engineer. If the split-spoon is driven 24 inches to maximize sample recovery, the second and third six-inch blow counts will be used to calculate the penetration resistance (N). Boring logs will be maintained, by the field engineer, to record each sample taken. As a minimum, the following information will be recorded on the boring logs:

1. Sample number;
2. Type of sampler;
3. Sample interval (ft.);
4. Blow count;
5. Sample recovery;
6. Preliminary USCS classification by visual inspection;
7. Unconfined compressive strength (Q_u), if sample is clay, as determined by a pocket penetrometer;
8. Depth of contact between soil strata;
9. Soil description and remarks.

A copy of a boring log legend and boring log are included in Appendix D.

All soil recovered in the split-spoon will be retained in sealed glass jars. As a minimum, the top of the jar will be labeled, with indelible ink, with the following information:

1. Job number;
2. Soil boring number;
3. Sample number;
4. Sample interval;

5. Number of jars containing sample (example: jar 1 of 3);

6. Sample date.

4.1.2.2 Pitcher Barrel Samples

Pitcher barrel samples will be retrieved over 24-inch sample intervals. Shelby tube samples will be acceptable if the penetration resistance is less than 20 blows per foot or more than 18 inches of undisturbed sample can be recovered.

Once a sample has been taken and the tube removed from the pitcher barrel assembly, the ends of the tubes will be coated with non-shrinking wax. Plastic caps will be placed over the ends of the tube and taped in place. The tube wall and top cap will be labeled with the following information as a minimum:

1. Job number;
2. Soil boring number;
3. Sample number;
4. Sample interval;
5. Sample recovery (inches);
6. Top of tube;
7. Sample date.

The samples will be preserved and transported in accordance with ASTM D4220. Specifically, the samples will be kept in a vertical position and kept at a temperature between 40° F and 100° F until the tubes are shipped to the soils laboratory. A copy of ASTM D4220 is included in Appendix C.

4.1.2.3 Harbor Sediment Samples

Approximately 25 gallons of sediment will be obtained from various locations in the Upper Harbor and Slip No. 3. The sediment samples will be recovered using a sampler dredge similar to the sampler shown in Appendix E. Since the samples will not be subjected to chemical analysis, the sampler may be constructed of other materials approved by the field engineer. Special care will be taken to assure the samples retrieved are representative of the harbor sediments and the finer fraction is not washed out during sampling. If the finer fraction of the sediments is washed out, the sample will be returned to the harbor and another sample retrieved.

4.1.3 In-Situ Permeability Tests

Two types of in-situ permeability tests will be performed in nine of the soil borings located on the slurry wall alignments. The first type will be designated as a vertical permeability test and the second type will be designated as a horizontal permeability test. The vertical test will utilize a pneumatically inflated seal (packer) located in the boring casing at a depth equal to the existing ground water level. The boring casing will be driven at least one foot into the clay till, the soil plug removed by rotary wash, and a permeability test conducted by pressurizing the water inside the casing and measuring the flow of water into the borehole. The measured permeability will be representative of the vertical coefficient of permeability. The laboratory permeability tests performed on pitcher

barrel samples will be compared to the field permeability tests from this method.

The horizontal test method will place the pneumatically operated seal (packer) in the bottom of the casing with an extending unlined borehole approximately three (3) feet below the end of the casing. After the packer is inflated inside the casing, the three foot test cavity will be pressurized and flow measurements recorded. The measured permeability will be representative of the horizontal coefficient of permeability. The horizontal test is the best available method for measuring the in-situ horizontal permeability.

Three borings along the slurry wall alignments will be selected for each of the three containment areas for the permeability tests. The vertical permeability test will be performed in one boring for each containment area, and the horizontal permeability test will be performed in two borings for each containment area. The field permeability data obtained from each boring will be used to design the depth of the slurry wall penetration into the underlying clay till such that the flow of water beneath the wall is less than or equal to the flow of water through the slurry wall.

The procedure for drilling the soil borings and performing the in-situ permeability tests is as follows:

For the horizontal test;

1. The borings will be advanced from the ground surface to the surface of the clay till by rotary wash drilling in a 6-inch diameter casing. Standard split-spoon samples will be recovered at 5-foot intervals.

2. HW steel casing (4-inch I.D.) will be lowered into the hole and driven at least one-foot into the till to assure an adequate seal is obtained between the till and the casing.
3. The drilling fluid will be flushed from the 4-inch casing with potable water.
4. The boring will be advanced by rotary wash methods with a 2-15/16 inch diameter tricone roller bit reaming the borehole remaining after each split spoon sample. Split-spoon samples will be obtained continuously through the clay till.
5. When the desired test cavity length (3 feet) is obtained, the borehole will be flushed with potable water to remove silt and sediments.
6. The packer assembly will be set in the hole such that the packer remains in the 4-inch casing but is at the end of the casing and the unlined soil borehole creates the test cavity. The packer is then inflated to seal the test zone.
7. The testing apparatus will consist of a pressurized reservoir of water capable of maintaining a constant pressure in the test cavity, while measuring the flow of water through the test cavity.
8. The test cavity pressures will be calculated to prevent hydrofracturing of the clay till as follows:

$$P_{\max} = P_o + P_{\text{allow}} + H_L$$

Where:

P_{\max} = Maximum Test Cavity Pressure

P_o = Hydraulic Pressure due to the Static Water Level

P_{allow} = Excess hydraulic pressure allowed due to the weight of overburden (0.5 psi per foot of depth to test section)

H_L = Friction head losses in the test apparatus valves and piping

Example:

Assume: $H_L = 0$, no friction head losses due to valves and piping.

Given:

Depth to ground water = 5 feet

Depth to top of clay = 25 feet

Depth to bottom of test cavity = 29 feet

$$P_o = (29-5) \times (62.4 \text{ pcf}/144 \text{ in}^2/\text{ft}^2) = 10.4 \text{ psi}$$

$$P_{\text{allow}} = 0.5 \text{ psi/ft} \times 29 \text{ ft.} = \underline{14.5} \text{ psi}$$

$$P_{\max} = 24.9 \text{ psi}$$

Use 24 psi for testing.

9. The horizontal permeability test will be run at $1/2 P_{\max}$, $3/4 P_{\max}$, P_{\max} , $3/4 P_{\max}$, and $1/2 P_{\max}$ to allow hydraulic pressures to dissipate uniformly and check for problems with the packer seal.

The flow into the test cavity will be recorded at 5-minute intervals. After one hour, if the flow rate over the last three (3) successive 5-minute intervals varies by less than 10 percent the test at that pressure is complete. If not, the test will continue until the flow rate over three (3) successive 5-minute intervals varies by less than 10 percent. The data is recorded on a field permeability test form attached in Appendix J.

10. The pressure versus flow is plotted to check for evidence of problems such as leakage around the packer, erosion of the test zone, and clogging of fissures. A high quality test will produce a linear relationship of pressure to flow with little difference between the pressurization toward P_{max} and depressurization away from P_{max} .
11. The horizontal permeability is calculated as shown in Appendix J on Figure 8-10.
12. If the horizontal permeability for the first 3-foot test section is equal to or less than 1×10^{-7} cm/sec, then no additional permeability tests will be performed in that boring. The packers and permeability apparatus will be removed and the borehole will be drilled and sampled to completion (20-foot penetration into the clay till or as required).
13. If the horizontal permeability in the test section is greater than 1×10^{-7} cm/sec, then the field engineer will determine, as discussed in the Work Plan, if the measured horizontal permeability combined with the measured vertical permeability provides a barrier to flow equivalent to the 3-foot wide slurry wall.

14. If the field engineer's determination indicates the in-situ soil in the first test section does not provide an adequate flow barrier, the boring will be advanced one-foot and the packer and permeability apparatus replaced. The permeability test will be repeated as before after recalculating P_{max} for the new test section.
15. The boring will be advanced in one foot increments and the permeability test repeated until the field engineer determines, as discussed in the Work Plan, the horizontal and vertical permeabilities in the in-situ soils will provide a barrier to flow that is equivalent to the 3-foot slurry wall.
16. The borehole will be backfilled by tremie grouting with cement/bentonite grout before removing the casings.

For the vertical permeability test;

1. The borings will be advanced from the ground surface to the surface of the clay till by rotary wash drilling in a 6-inch-diameter casing. Standard split-spoon samples will be recovered at 5-foot intervals.
2. HW steel casing (4-inch I.D.) will be lowered into the hole and driven at least one foot into the till to assure an adequate seal is obtained between the till and the casing. The HW casing will consist of a single piece of pipe with no joints below the ground water level and a beveled end for driving into the clay till.
3. The drilling fluid will be flushed from the 4-inch casing with potable water and the clay plug will be removed by rotary wash

drilling. The water will be pumped or bailed from the casing to within two feet above the existing ground water level.

4. The single packer assembly will be set in the 4-inch casing such that the packer is at the existing ground water level. The packer is then inflated to seal the casing.
5. The testing apparatus will consist of a pressurized reservoir of water capable of maintaining a constant pressure in the test cavity while measuring the vertical flow of water through the soil plug in the bottom of the casing.
6. The test cavity pressures will be calculated to prevent hydrofracturing as follows:

$$P_{\max} = P_o + P_{\text{allow}} + H_L$$

Where: P_{\max} = Maximum test cavity pressure
 P_o = Hydraulic pressure due to static water level
 P_{allow} = Excess hydraulic pressure allowed due to weight of overburden (0.5 psi per foot of depth to test section)
 H_L = Friction head losses in test apparatus valves and piping

Example:

Assume: $H_L = 0$, no friction head losses due to valves and piping

Given:

Depth to ground water = 5 feet
Depth to top of clay = 25 feet
Depth to bottom of casing = 26 feet

$$\begin{aligned}P_o &= (26-5) \times (62.4 \text{ pcf}/144 \text{ in}^2/\text{ft}^2) = 9.2 \text{ psi} \\P_{\text{allow}} &= 0.5 \text{ psi/ft} \times 26 \text{ ft} = \underline{13.0} \text{ psi} \\P_{\text{max}} &= 22.1 \text{ psi}\end{aligned}$$

CAUTION: Because the packer is set at the ground water level, P_o is already applied to the test cavity.

Therefore, the testing apparatus gauges only need to record the P_{allow} . The calculations for permeability however are dependent on P_{max} .

7. The single packer permeability test will be run at $1/2 (P_{\text{allow}} + H_L)$, $3/4 (P_{\text{allow}} + H_L)$, $P_{\text{allow}} + H_L$, $3/4 (P_{\text{allow}} + H_L)$, $1/2 (P_{\text{allow}} + H_L)$ to allow hydraulic pressures to dissipate uniformly and check for problems with the packer seals or casing seal. The flow into the test cavity will be recorded at 5-minute intervals. After one hour, if the flow rate over the last three (3) successive 5-minute intervals varies by less than 10 percent the test at that pressure is complete. If not, the test will continue until the flow rate over three (3) successive 5-minute intervals varies by less than 10 percent. The data is recorded on a field permeability test form attached in Appendix J.
8. The pressure versus flow is plotted to check for evidence of problems such as leakage around the packer, erosion of soil through the test zone, and clogging of fissures. A high quality

test will produce a linear relationship of pressure to flow with little difference between the pressurization toward $P_{allow} + H_L$ and depressurization away from $P_{allow} + H_L$.

9. The vertical permeability is calculated as shown in Appendix J on Figure 8-11 and will be compared to the laboratory permeability test results on pitcher barrel samples.
10. The boring will be completed with continuous split-spoon sampling to the specified depth of penetration into the clay till. Between samples the borehole will be reamed with a 2-15/16 inch diameter tricone roller bit.
11. The borehole will be backfilled by tremie grouting with cement/bentonite grout after removing the casings.

4.1.4 Rock Core Drilling

All rock coring will be performed with an NX (2-5/32 in.) diamond tip core barrel assembly. The rock coring will be performed in accordance with the requirements of ASTM D-2113. A copy of the specification is attached in Appendix C. All recovered cores will be placed in commercial plastic, cardboard, or shop-made wooden boxes, and the beginning and end of each core run will be properly marked with the blocks provided. Rock core logs will be maintained by the field engineer to record each core obtained. As a minimum the following information will be recorded on the core log:

1. Sample number;
2. Length of core run;
3. Core size;

4. Coring pressure (PSI);
5. Rate of core advance (ft./min.);
6. Percent core recovery;
7. RQD;
8. Number of fractures per foot;
9. Bedding;
10. Hardness;
11. Description of rock core.

A copy of a rock core legend and rock core log are included in Appendix F.

4.1.5 Piezometers

The installation procedures for piezometers are described in the Work Plan. Therefore, only material requirements will be described in this section.

The installation of each piezometer will be logged on an observation well diagram. All well construction information will be recorded to the nearest tenth of a foot. A copy of a blank observation well diagram and a typical well detail diagram are included in Appendix G.

4.1.5.1 Piezometers in Silurian Bedrock

4.1.5.1.1 PVC Screens

Piezometer screens will be machine-slotted, one-inch-diameter Schedule 80 PVC, with at least three rows of slots. The slot openings will be .01 inches for all piezometers. The screen section will be threaded for attachment to the riser pipe and the bottom of the screen will be provided with a threaded PVC plug. The screen and 10 feet of riser pipe above the screen zone will be free of ink and any other markings.

4.1.5.1.2 PVC Riser Pipe

Riser pipe for the piezometers will consist of Schedule 80 PVC pipe meeting ASTM D-1785 with flush joint threads. A copy of the specification is included in Appendix C.

4.1.5.1.3 Sand Pack

Sand pack is the material placed in the annular space around the well screen. The pack shall be uniformly graded sand or gravel, comprised of hard, durable particles which have been washed with potable water and screened. The sizing of the particles shall be determined by the soil type encountered in the zone to be monitored. The particle size of the pack shall be at least 4 times the D15 size (15 percent of the soil is finer than this dimension) of the soil in the monitored zone and shall be no more than 4 times the D85 size (85 percent of the soil is finer than this dimension) of the soil in the monitored zone. The sand pack shall be free of all organic matter and shall not contain detectable concentrations of any chemical constituents. The sand pack shall be furnished in unopened bags or pails.

4.1.5.1.4 Bentonite Seals

A bentonite seal is used in the annular space above the piezometer screen. The bentonite seal will consist of Volclay grout. Volclay grout is a high solid bentonite based clay grout. The grout will be placed using the tremie method. The Volclay grout will consist of the following proportions:

1. 52 pounds of Volclay grout (includes 2 pounds of initiator);
2. 24.4 gallons of fresh water.

The Volclay grout will be provided to the job site in full, unopened bags. The Volclay grout, initiator, and water will be mixed to a uniform consistency, free of lumps. A mud balance test will be run on each batch prior to placement, and the slurry weight must achieve a minimum of 9.4 pounds per gallon at time of placement. The grout will be installed by the tremie method.

4.1.5.1.5 Concrete

Concrete is required for capping the annular space in piezometers and simultaneously providing a solid base for supporting the piezometer riser pipe protective cover.

Concrete shall be provided to the job site in full, unopened bags such as Sakrete, or in a premixed state from a local concrete supplier.

4.1.5.1.6 Placement of Protective Cover

A carbon steel pipe, having an inside diameter of at least 1.33 times the outside diameter of the piezometer's riser pipe, shall be set concentrically around the riser pipe and into the concrete cap. The bottom of the well protector shall be submerged at least three feet into the concrete, and shall extend at least six inches above the top of the riser pipe. The concrete which is forced out of the borehole due to the placement of the well protector shall be carefully removed so as to prevent "mushrooming" of the concrete at the ground surface, which tends to promote lifting of the well casing and the well protector during frost heave conditions. The well protector shall be maintained plumb and concentric with the riser pipe until the concrete has set. Temporary braces may be required to maintain the well protector in the proper vertical position. A locking cap shall be secured to the top of the well protector pipe to prevent unauthorized entry into the well.

4.1.5.2 Piezometers in Shallow Aquifers

4.1.5.2.1 PVC Screens

The material requirements for PVC screen in shallow aquifer piezometers is the same as for the piezometers in Silurian bedrock, Section 4.1.5.1.1.

4.1.5.2.2 PVC Riser Pipe

Riser pipe for the piezometers will consist of Schedule 80 PVC pipe meeting ASTM D-1785 with flush joint threads. A copy of the specification is included in Appendix C.

4.1.5.2.3 Sand Pack

The material requirements for sand packs in shallow aquifer piezometers are the same as for the piezometers in Silurian bedrock, Section 4.1.5.1.3.

The shallow aquifer sand may be used for the sand pack if the engineer determines that it is acceptable.

4.1.5.2.4 Concrete

The material requirements for concrete in shallow aquifer piezometers is the same as for the piezometers in Silurian bedrock, Section 4.1.5.1.5.

4.1.5.2.5 Placement of Protective Cover

The requirements for placement of protective cover in shallow aquifer piezometers is the same as for the piezometers in Silurian bedrock, Section 4.1.5.1.6.

4.1.6 Developing Existing Monitoring Wells

4.1.6.1 Cleaning of Equipment and Material

All pumps to be used in development, purging, or pumping of wells at the site shall be steam cleaned and all wetted parts, hoses, and valves flushed thoroughly with water from the source approved by the field engineer. Pumps which leak or otherwise may introduce chemical constituents into the well, sampled water, or aquifer shall not be used. Electrical lines to submersible pumps shall meet all applicable electrical code standards. Electrical lines to submersible pumps may be attached to the discharge pipe or hose of the pump by stainless steel or plastic fasteners which grip by means of a

mechanical action only. No electrical tape shall be used to attach electrical lines to the discharge pipe or hose.

Compressors utilized in the development, purging, or pumping of wells at the site shall be equipped with an operable oil trap and in-line air filter. The oil trap and filter shall be checked by the field engineer prior to each day's use. The oil trap and filter must be capable of removing entrained oil from the compressed air to prevent introduction of chemical constituents into the sample water or the ground water.

If bladder pumps are utilized and powered by compressed nitrogen, the nitrogen gas shall be pressure regulated at the tank and shall pass through an in-line oil trap and filter before it enters the well or pump. The source of nitrogen gas shall be indicated in the daily log for the site activities.

4.1.6.2 Existing Well Development

Existing monitoring wells shall be developed, by pumping or other means of evacuating the well casing, in order to remove the sediments within the casing, any trapped soil fines in the gravel pack and soil formation just outside the pack and to produce a representative sample of the water in the formation.

Well development may be accomplished through the use of submersible, bladder, jet, or suction pumps. Pumps must be fully operational, meet applicable electrical or other code provisions, and must be thoroughly cleaned in accordance with procedures set forth in Section 4.1.6.1. Pump capacity shall be rated at three to five gallons per minute. Pumps shall be operated to remove water from the well casing continuously for at least five minutes without pumping the well dry. As an alternative to pumping, an air lift may be utilized to evacuate and surge the well. Where the nature of the

formation or recharge to the well makes development of the well infeasible using pumps, bailers may be utilized.

Well development shall continue until representative formation water is obtained. Representative formation water shall be defined as water which is generally free of sediment, and has a stable pH, temperature, and specific conductivity when measured within a period of ten minutes. In general, well development shall proceed for at least two hours, unless prior experience suggests that a shorter well development period results in the production of formation water which is representative. Well development water will be discharged onto the ground near the well.

4.1.7 Cement/Bentonite Grout

Cement/bentonite grout is required for backfilling completed soil borings. The grout will consist of the following proportions per bag of Portland cement:

1. 7.3 gallons of clean water;
2. 4.0 pounds of sodium bentonite powder;
3. 94 pounds of Type I Portland cement.

The cement and bentonite will be provided to the job site in full, unopened bags. The bentonite powder and water will be mixed first. Cement will not be added to the mixture until the bentonite and water is mixed to a uniform consistency, free of lumps. At the discretion of the field engineer, the amount of cement can be increased. The grout will be installed by the tremie method.

4.2 Laboratory Testing Program

The specific tests that comprise the laboratory testing program and the number of tests required is described in Section 2.2 of the Work Plan. The purpose of this section is to define the standards to which each laboratory test will comply.

All laboratory testing will be supervised by a qualified engineer. Care will be taken in handling all samples so that the integrity of the sample is not damaged. When obtaining a sample of harbor sediments, from the sample container, special care will be taken to assure that the finer fraction of the sediments is included in the sample.

4.2.1 Moisture Content Analysis

All moisture content analysis will be performed in accordance with ASTM D2216. All data will be recorded on appropriate laboratory forms. A copy of ASTM 2216 and a laboratory form are included in Appendices C and H, respectively.

4.2.2 Mechanical Sieve Analysis

All mechanical sieve analysis will be performed in accordance with ASTM D422. Hydrometer analysis will not be performed as part of a mechanical sieve analysis. All data will be recorded on appropriate laboratory forms and summarized on semi-logarithmic grain-size curves. A copy of ASTM D422, a laboratory form, and grain-size curve are included in Appendices C, H, and H, respectively.

4.2.3 No. 200 Sieve Wash

The amount of material that is finer than a No. 200 sieve will be determined in accordance with ASTM D1140. All data will be recorded on appropriate laboratory forms. A copy of ASTM D1140 and a laboratory form are included in Appendices C and H, respectively.

4.2.4 Standard Proctor Test

All standard Proctor tests will be performed in accordance with ASTM D698. Care will be taken to assure that each layer, in the test, is comprised of the same amount of soil and the same compactive effort is applied to each layer. All laboratory data will be recorded on appropriate laboratory forms. A copy of ASTM D698 and a laboratory form are included in Appendices C and H, respectively.

4.2.5 Consolidation Tests

All consolidation tests will be performed in accordance with ASTM D2435. The consolidation apparatus will be located in the lab so that disturbance due to vibration, movement of laboratory personnel, etc. is minimized. All consolidation data will be recorded on appropriate laboratory forms. A copy of ASTM D2435 and laboratory forms is included in Appendices C and H, respectively.

4.2.6 Atterberg Limits

All Atterberg limits tests will be performed in accordance with ASTM D4318. All test data will be recorded on appropriate forms. A copy of ASTM D4318 and laboratory forms are included in Appendices C and H, respectively.

4.2.7 Permeability/Compatibility Test

The constant head permeability test for fixed-soil samples will be performed in a modified triaxial consolidation apparatus. For this method, a flexible rubber membrane encloses the soil sample. Water is pressurized on the outside of the flexible membrane to hold the membrane against the side of the soil sample. Water from the site is introduced under pressure at the bottom of the sample and allowed to move vertically through the sample until full saturation is achieved. A copy of the triaxial cell permeability log sheet and calculation sheet are included in Appendix H.

The procedure for the permeability test is as follows:

1. The length and diameter of the sample is measured both before and after the testing for permeability.
2. The sample is enclosed within a synthetic flexible membrane with a porous stone on both the top and the bottom ends.
3. Drain lines are attached to both the top and bottom caps and the triaxial cell is assembled. The annulus between the cell wall and sample is flooded with de-aired tap water.
4. Both the inflow and outflow measuring burettes and their attaching lines are filled with the water being utilized.
5. The cell pressure (pressure confining the soil sample within the rubber jacket) is increased slowly to 40 psig. The pressures on the influent and effluent burettes are then set to create a differential pressure across the sample. The influent burette pressure is set at 35 psig and the effluent pressure is set at

15 psig, creating a differential pressure across the sample of 20 psig. This is equivalent to 46 feet of water pressure.

6. The flow in and out of the sample is monitored on a daily basis. The samples will be tested for a period adequate to displace one to three sample pore volumes.
7. The permeability is calculated from the dimensions, pressure differential, and the flow rates for each sample.

The permeability for each sample is determined from Darcy's law for steady-state laminar flow. The rearrangement of Darcy's law used to calculate the permeabilities of the sample is:

$$k = q l / (hA)$$

Where: k = permeability (cm/sec)
 q = flow rate (cm³/sec)
 l = length (cm)
 h = pressure differential (cm)
 A = total cross sectional area of the sample that is perpendicular to the flow (cm²)

The permeability values are plotted as a function of the displaced pore volumes. Examination of the relationship between permeability and pore volume displacement is the basis for determination of the compatibility of the soil/bentonite backfill, and natural soils with on-site ground water and with water that is in contact with PCB sediments.

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The permeability tests for the pitcher barrel samples and recompacted clay samples will be performed as above, but different pressures will be used. The cell pressure will be 52 psig, the influent pressure will be 50 psig, and the effluent pressure will be 30 psig.

5.0 CUSTODY OF SAMPLES

An established program of sample chain-of-custody procedures, that is followed during sample collection and handling activities in both the field and laboratory operations, shall be established to assure that sample integrity is maintained and data generated through the analysis of the samples is applicable to evaluation of the site. The program is designed to assure that each sample is accounted for at all times. To maintain the highest degree of control in sample handling, preprinted labels will be utilized so that all necessary information is retained with the sample, and chain-of-custody records and shipping manifests will be employed to maintain control over access to and destination of samples after shipment from the location of sample collection. Additionally, proper completion of field sample logs, accession books, tracking sheets, and extraction logs by appropriate field and laboratory personnel will provide for thorough monitoring of the samples from collection through analysis and final report generation.

The sample identification, custody, and monitoring procedures shall assure that:

1. All samples collected are uniquely labeled for identification purposes throughout the analytical process;
2. Samples are correctly analyzed and that results are traceable to field records;
3. Important sample characteristics are preserved;
4. Samples are protected from loss, damage, or tampering;

5. Any alteration of samples (e.g., filtration, preservation, or damage due to shipment or other processes) is documented;
6. A record of sample integrity and analytical fate is established for legal purposes.

5.1 Sample Monitoring Forms

The use of the indicated forms listed above accomplishes one or more of the specific objectives of sample custody, identification, or control. The use of each of the listed forms is discussed below.

5.1.1 Sample Log

The sample log is completed in the field by the individual physically in charge of the sample collection. The sample log correlates the assigned sample bottle designation to a specific well or sample location or other distinguishing feature or attribute (i.e., dummy sample, replicate sample, purge evaluation sample, etc.). The sample log also contains information concerning day and time of sampling, type, location, and depth for wells, water depth in the well, purge volume, purge water temperature, pH, and conductivity as a function of time, procedures utilized to preserve the sample for analysis, and the sequence in which sampling was completed. Other relevant information, such as weather conditions, may also be included.

5.1.2 Chain-of-Custody Record

The chain-of-custody record is completed in the field by the individual physically in charge of the sample collection. The chain-of-custody record may be completed contemporaneously with the sample log or prior to the

shipment of samples to the laboratory. The chain-of-custody record contains information on the date of sample collection, the sampler, the project name and number, laboratory project number, the number of containers of each sample being shipped, and an itemization of the analyses requested for each sample together with any remarks about the sample prior to shipment. The chain-of-custody record is enclosed with the samples after it has been signed by the sampler. The record is then signed each time possession of the samples changes, with the signature of the person relinquishing and receiving the sample, as well as the time of exchange being indicated on the record. A sample copy of a chain-of-custody form is set forth on Attachment III of Appendix A.

5.1.3 Accession Book

The accession book is maintained at the receiving analytical laboratory by the sample custodian. When samples arrive from the field, each container is assigned a laboratory number which is then logged into the accession book. Other important information entered into the accession book includes the name of the shipping firm or person who delivered the samples to the laboratory, the date received and the individual taking custody, the container size and any comments related to possible mishandling, abuse or obvious damage to the shipping container or contents, the name of the client, the date and time of sample collection, the samplers initials, and the site from which the samples originated. The accession book becomes the permanent record of all samples received by the laboratory for analysis. A sample page from the accession book is presented on Attachment V of Appendix A.

5.1.4 Tracking Sheets

The tracking sheets are developed at the time the samples are logged into the accession book. Each sample received at the analytical laboratory has

its own unique tracking sheet. The tracking sheet contains the date the sample was taken, received by the laboratory, prepared for analysis, and finally analyzed. Results of analysis as well as dilution of the sample or any other conditions used are also noted. Tracking sheets are utilized for presumptive as well as confirming analysis. Final reports are generated from the information on the tracking sheets. The tracking sheet for each sample, as well as any notes, chromatographic charts, and atomic absorption printouts are permanently filed in the records of the laboratory. A sample tracking sheet is presented on Attachment IV of Appendix A.

5.1.5 Extraction Log

Various types of analyses require that sample extraction and subsequent volume reduction occur. Each sample which undergoes this process is recorded in the extraction log with information on all conditions which existed during the creation of the final extract. Typical information includes the sample number, initial volume, final volume, date the extraction/volume reduction was produced, analyst performing the work, the methodology utilized, and any comments about the nature of the sample. The extraction log is a permanent record maintained by the analytical laboratory.

The flow of samples and analytical data within the Canonic analytical laboratory is illustrated on Figure 3. Omitted for clarity are procedures which involve calibration of instrumentation for each analytical run and verification of instrument detection limits, which are conducted on a quarterly basis.

5.2 Reagent Documentation

Written documentation of reagents utilized in the analytical laboratory is maintained in a reagent record book. Information maintained includes the

date the stock is made, the analyst preparing the stock, the weight or volume of all materials used in the creation of the stock, the source of the chemical, and the source lot number. The record includes information for stock standards, intermediate stock, and quality assurance stock. U.S. EPA protocols shall be followed in the creation and testing of all stock. All stock bottles are clearly labeled with the exact contents of the bottle, the concentration, the date of creation, the expiration date, and the analyst who created the stock. Reagents are stored at conditions appropriate for each stock, and are discarded after standard permissible holding times have been exceeded or if contamination or decomposition of the stock is evident.

For general inorganic analysis, Analytical Reagent (AR) grade reagents are utilized. Metal analysis performed via atomic absorption spectroscopy employs reagents and solvents of spectroquality. For organic analysis, the minimum purity shall be AR grade. For high pressure liquid chromatography (HPLC), HPLC grade solvents shall be used. Where requested analysis requires more stringent grades of reagents, those reagents shall be utilized. All base stock for the creation of reagents in the laboratory are purchased from reputable suppliers and are of the requisite standard purity. Typical commercial suppliers which may be used for the purchase of base stock and standards include Supelco and Chem Service, along with Foxboro, J. T. Baker, Fisher Scientific, Aldrich, and American Scientific. Several sources are used so that a contamination or defect in one source can be detected, by comparison against another source, before a great deal of false analytical results are reviewed and published. The use of multiple source in stocking the laboratory's chemical needs, therefore, promotes additional quality assurance throughout the analytical process. Stock and standard solutions are tracked in a manner illustrated on the forms presented as Attachments VII, VIII, and IX of Appendix A.

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5.3 Packing and Shipping

In addition to sample collection and preservation requirements, especially the maintenance of sample temperature at 4 degrees C until extraction or analysis, samples should be packed and shipped properly to maintain the health and safety of sample transporters. Guidelines for packing and shipping of samples are included in Appendix I.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 Calibration Procedures for Laboratory Equipment

Equipment shall be calibrated in accordance with procedures presented in the appropriate ASTM specifications.

6.2 Calibration Procedures and Frequency for Field Instruments

Equipment utilized in the field shall be calibrated prior to each day's use. The procedures for each piece of equipment which will be utilized are set forth below. If other instruments are used, the manufacturer's calibration procedures shall be followed.

6.2.1 Thermometer

Using a National Bureau of Standards-approved thermometer, immerse both the field thermometer and NBS-approved thermometer into a beaker of water and note any differences for the field probe.

Recalibrate the field probe as necessary.

6.2.2 Specific Conductance Meter

Calibrate meter and probe using the calibration control and the conductance calibration line on the meter dial or a standard solution of known conductance.

Turn the function switch to read conductivity x 10 and then depress the cell test button, noting the deflection. If the needle falls more than two percent of the reading, clean the probe and retest.

Using at least two potassium chloride buffer solutions which will most likely bracket the range of expected conductivity, note accuracy of the meter and probe and clean probe if necessary.

6.2.3 pH Meter

Place electrodes and the manufacturer's supplied buffer solutions in a water bath at the temperature of the water to be sampled. After temperature equilibrium has been established, measure the temperature and adjust the temperature compensation knob for the temperature indicated.

If refillable electrode probes are used, remove the electrode cap and check that probe solution is above the full mark.

Immerse the probe in the pH 7 buffer solution and adjust the calibration control to read pH 7.

Remove the probe, rinse with distilled water and then immerse in either the pH 4 or pH 10 buffer solution, depending on the expected pH of the sample solution.

If the pH meter does not register the correct pH for the buffer solution tested, adjust the calibration knob on the back of the instrument so that the meter reads the correct pH as defined by the buffer solution tested.

After rinsing the probe, insert the probe into the sample to be tested and allow the probe to come to equilibrium with the sample water prior to recording the readout.

7.0 ANALYTICAL PROCEDURES

7.1 Selection of Parameters

The selection of parameters for the project is made through an evaluation of existing data and an analysis of data needs with respect to the project objectives. The parameters of interest are designated in the pre-design phase of the Work Plan, and particular parameters to be addressed in each sample are noted.

7.2 Selection of Procedures

Procedures to be utilized in accomplishing the activity described in the pre-design phase of the Work Plan shall be in accordance with methods, protocols, and procedures set forth in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8080, U.S. Environmental Protection Agency, 1982, Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201796, Method 608, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1982, and relevant materials testing methods approved by the American Society of Testing and Materials (ASTM), including the following listed here that are included in Appendix C:

- ASTM D1586 Method for Penetration Test and Split-Barrel Sampling of Soils
- ASTM D4220 Practices for Preserving and Transporting Soil Samples
- ASTM D2113 Practice for Diamond Core Drilling for Site Investigation
- ASTM D1785 Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
- ASTM D2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
- ASTM D422 Method for Particle-Size Analysis of Soils

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- ASTM D1140 Method for Amount of Material in Soils Finer than the
No. 200 (75-um) Sieve
- ASTM D698 Methods for Moisture-Density Relations of Soils and Soil-
Aggregate Mixtures Using 5.5-lb. (2.49-kg) Rammer and 12-
in. (305-mm) Drop
- ASTM D2435 Method for One-Dimensional Consolidation Properties of
Soils
- ASTM D4318 Method for Liquid Limit, Plastic Limit, and Plasticity
Index of Soils

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective identified in Section 3.5 of this plan. Calculations completed during data reduction of analytical results shall be in accordance with approved U.S. EPA analytical methods and procedures.

Field data collection and validation will follow the process illustrated on Figure 2. Once the data is obtained, it is reviewed and assessed for overall adequacy by the Operations Coordinator. If it is determined that the initial data collection activity, or a portion thereof, did not provide adequate data, the activity will be repeated.

Calculations performed during data reduction shall be reviewed by the chemist performing the analysis, by the engineer/scientist/technician collecting data in the field, or by the engineer/scientist evaluating data in the laboratory, prior to the release of any data reporting, thus assuring that reporting errors are kept to a minimum. Laboratory review of data reduction is illustrated on Figure 3.

Analytical results reported for each sample shall be verified to assure proper identification by comparing the original sample collection logs with the chain-of-custody forms and the various laboratory log books. Based upon the results of this validation procedure, the laboratory shall certify that the results are in compliance with the quality assurance objectives for accuracy and precision. Upon certification by the laboratory manager, the reported values shall be received and reviewed by the technical staff and the Quality Assurance Coordinator, if deemed necessary. Analytical data shall be presented in a format illustrated by Figure 4.

Field or analytical data entered into the corporate computer database for storage, analysis, or report generation, shall be initially submitted to the Manager of Data Processing, or his designee. Data submitted for entry has been checked and verified by the engineer, scientist, chemist, or technician as being accurate and complete, and meeting the quality assurance criteria established for the phase of work in which the data was developed. Data is then entered into the computer by data entry operators using standardized entry forms developed especially for the type of data under consideration.

After entry of the data into the computer, a hard copy printout of the data is generated and the printout is compared directly with the original data sheets. A data entry operator who was not involved in the original entry of the data to the computer reviews the hardcopy printout. Each entry is reviewed, and inaccurate entries are highlighted. After review is complete, the hardcopy printout is returned to the original data entry operator and the noted inaccuracies are corrected. A final printout of the data is generated by the computer and the corrected version of the database is reviewed. After all corrections have been made to the database, the original data sheets are stamped "POSTED", and filed in the office's central file.

Data, information, or designs, submitted to the drafting department for development, are initially prepared by the engineer or scientist charged with the responsibility for creation of a graphical representation. The sketch or graphic representation is then reviewed by the engineer or scientist originating the material and the chief draftsman for format, intent, and consistency with prior work. The drawing is then assigned a unique project drawing number, the number and title of the drawing is entered into the drafting department log, and a draftsman is assigned to formally develop the drawing. After completing the initial presentation of the drawing, a paper check print is produced for review by the originating engineer or

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scientist. All information on the check print is reviewed and approved information is highlighted with a yellow highlighter marker, while incorrect information, changes, or additions are noted in red ink. The check print is then returned to the draftsman for correction, and a final check print is issued for review. Upon approval of the final check print, the originating engineer or scientist signs and dates the mylar original. The drawing is then reviewed by the task leader or project manager for consistency with project objectives, and then the task leader or project manager signs and dates the original mylar.

Revisions to previously approved mylar drawings are submitted to the drafting department on paper prints of the original mylar. Revisions are made to the mylar, with a review process occurring as noted above for original work. When the revisions are finally approved, a notation of the revision scope is noted in the margin of the drawing, and the dated, revised drawing is then signed by the individual approving the revision as presented.

9.0 INTERNAL QUALITY CONTROL ANALYTICAL LABORATORY

This section is included for analysis of PCBs for the water treatment assessment. The internal quality control standards for the laboratory are presented in Appendix A. The following sections from Appendix A are appropriate and relevant for the laboratory analytical work for the pre-design phase.

Section 1	Introduction
Section 2	Personnel
Section 4	Sample Custody
Section 5	Calibration and Maintenance Procedures Pages 16, 24, 25, 26, and 28
Section 6	Analytical Procedures, Page 37
Section 7	Data Review and Reporting
Section 8	Quality Control
Section 9	Establishment of Acceptable Limits
Section 10	Acceptance Criteria and Problems
Section 11	Analysis of External Reference Samples
Section 12	Review of Analytical Results by the Quality Assurance Officer

10.0 AUDITS

Quality assurance audits are performed to assure and document that quality control measures are being utilized to provide data of acceptable quality and that subsequent calculations, interpretation, and other project outputs are checked and validated. The quality assurance coordinator or a member of the quality assurance review team will visit the site periodically and unannounced to assure that the designated control procedures set forth in this document are practiced.

At least one system and performance audits may be conducted by the Quality Assurance Coordinator. The Quality Review Team will conduct project audits of calculations, interpretations, and reports which are based on the measurement system outputs.

10.1 Systems Audit

At least one systems audit may be conducted on all components of measurement systems to determine proper selection and utilization. The systems audit shall include evaluation of both field and laboratory procedures.

10.1.1 Organization and Personnel

The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be reviewed to determine that assigned responsibility, skill, and training of the personnel are properly matched to the requirements of the project. The Technical Project Director will maintain firsthand knowledge of his/her team's capabilities and will

discuss the organization's efficiency with the Quality Assurance Coordinator. Assigned personnel may be interviewed by the Quality Assurance Coordinator during an audit.

10.1.2 Facilities and Equipment

The audit will address whether field tools, analytical instruments, and construction equipment selected and meet the requirements specified by the project objectives stated in this Plan and other project work plans. Equipment and facilities provided for personnel health and safety will also be evaluated.

10.1.3 Analytical Methodology

Routine external performance evaluations as well as blind internal performance evaluations will be conducted in accordance with standard procedures of the U.S. EPA. A review of analytical methodology in regard to the data requirements for the project will also be performed. An on-site observation of analyst technique, data reduction, and recordkeeping may be performed if determined necessary. Periodic review of the precision and accuracy of data shall also be performed.

10.1.4 Sampling and Sample Handling Procedure

An audit of scheduled samples versus samples collected versus samples received for analysis shall be performed. Field documentation will be reviewed. If deemed necessary, a site visit will be made to assure that designated control procedures are practiced during sampling activities.

10.1.5 Data Handling

During a systems audit, the Quality Assurance Coordinator will review data handling procedures with the Technical Project Director and Task Leaders. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed.

10.2 Performance Audit

These audits are intended primarily for analytical and data generation systems. The laboratory will complete its own performance evaluations as discussed in Appendix A.

10.3 Project Audit

Project audits encompass the aspects of both the systems audit and the performance audit. The project audit typically occurs at least twice for a short-term project and more often during long-term projects. Timing is keyed to the systems involved and the project objectives.

10.4 QA Audit Report

A written report of the Quality Assurance audit may be prepared to include:

1. An assessment of task force's status in each of the major project areas;
2. Clear statements of areas requiring improvement or problems to be corrected. Recommendation and assistance will be provided regarding proposed corrective actions or system improvements. If no action is required, the report will state that the QA audit was satisfactorily completed.

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3. A timetable for any corrective action required;
4. A follow-up to assure that recommendations have been implemented.

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11.0 PREVENTIVE MAINTENANCE

Preventive maintenance of all field equipment proceeds routinely before each sampling event; more extensive maintenance is performed on the basis of hours in use.

Laboratory equipment is maintained on a regular, scheduled basis. This maintenance is documented in the laboratory records book for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under repair and maintenance contracts with factory representatives.

12.0 DATA ASSESSMENT

The purpose of data quality assessment is to assure that data generated under the program is accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, consistency, and completeness of the data that is measured or generated.

Data quality assessment will be conducted in three phases:

12.1 Phase 1

Prior to data collection, sampling and analytical procedures will be evaluated in regard to their ability to generate the appropriate technically acceptable information required to achieve project objectives. This Quality Assurance/Quality Control Plan meets this requirement by establishing project objectives defined in terms of parameters, analytical methods, and required performance levels.

12.2 Phase 2

During data collection, results will be assessed to assure that the selected procedures are efficient and effective, and that the data generated provides sufficient information to achieve project objectives. Precision and accuracy of measurement systems will also be evaluated. In general, evaluation of data will be based on performance audits and review of completeness objectives.

Documentation will include:

1. Number of replicate samples collected;

2. Number of replicate, spike, and field blank samples analyzed;
3. Use of historical data and its reference;
4. Identification of analytical method used;
5. Evaluation of the data package, which will include:
 - o Initial calibration and calibration verification.
 - o Continuing calibration verification after every 20 samples for elemental parameters and daily for semi-volatiles.
 - o Spiked sample analysis after every 10 samples for elemental parameters and after every 20 samples for semi-volatiles.
 - o 10 percent preparation blank analysis.
 - o One duplicate sample analysis for every 10 samples.

The technical director of Canonie's laboratory will be responsible for any additional evaluation required of analytical data packages.

12.3 Phase 3

Throughout the data collection activities, an assessment of the adequacy of the database generated in regard to completing the project objectives will be undertaken. Recommendations for improved quality control will be developed, if appropriate. In the event that data gaps are identified, the Quality Assurance Coordinator or Quality Review Team may recommend the collection of additional raw data to fully support the project's findings and recommendations.

13.0 CORRECTIVE ACTION

Corrective or preventive action is required when potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective action could be immediate or long-term. In general, any member of the program staff who identifies a condition adversely affecting quality can initiate corrective action by notifying in writing his or her supervisor and the Quality Assurance Coordinator. The written communication will identify the condition and explain how it may affect data quality or quantity. Corrective action in the field is the responsibility of each individual of the on-site staff, with review of procedures to be used occurring prior to sampling episodes and a check of the procedures implemented taking place after the sampling episode is completed.

Corrective actions with regard to laboratory analyses are the responsibility of the designated laboratory. In general, situations which may require corrective action are identified through the analysis of travel blanks and blanks retained in the laboratory, which would show any potential contamination of samples by incorrect laboratory preparation procedures or through the shipping phase, if it existed. These blanks are included in each sample set shipped to the laboratory, providing a constant check on these two potential sources of error. During analysis, the typical procedure which the chemist utilizes in testing the samples involves the analysis of a laboratory blank, a calibration sample, a laboratory blank, several field samples, a live spike, a spiked laboratory blank, and several duplicates and/or replicates. Overall quality control in the laboratory is maintained by utilizing quality control standards which are prepared independently from calibration standards. Preparation of quality control standards may be by a chemist not directly involved in the preparation of the calibration standards, by an outside laboratory, or by a manufacturer/supplier of laboratory supplies. The acceptance or rejection of analytical data is

contingent upon the results of analysis presented for the quality control and calibration standards. The plotting of quality control data on a chart allows for continued tracking of quality control procedures and results, with this information as well as all analytical results retained in the files for future reference and review.

13.1 Immediate Corrective Action

This type of corrective action is usually applied to spontaneous, non-recurring problems, such as an instrument malfunction. The individual who detects or suspects nonconformance to previously established criteria or protocol in equipment, instruments, data, methods, etc., will immediately notify his/her supervisor. The supervisor and the appropriate task leader will then investigate the extent of the problem and take the necessary corrective steps. If a large quantity of data is affected, the task leader must prepare a memorandum to the Project Manager, the client, and the Quality Assurance Coordinator. These individuals will collectively decide on a course of action to correct the deficiencies while the project continues to proceed. If the problem is limited in scope, the Task Leader will decide on the corrective action measure, document the solution in the appropriate workbook, and notify the Project Manager, the client, and the Quality Assurance Coordinator in memorandum form.

13.2 Long-term Corrective Action

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The Quality Assurance Coordinator will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. The Quality Assurance Coordinator will then file a corrective action request with the Project Manager and Quality Review Team. In case of dispute

between the Quality Review Team and the Project Manager, the Responsible Corporate Officer will make a final determination for the company.

Corrective actions may also be initiated as a result of other activities including:

- o Performance Audits;
- o System Audits;
- o Laboratory/field comparison studies;
- o Quality Assurance/Quality Control program audits conducted by the Quality Review Team.

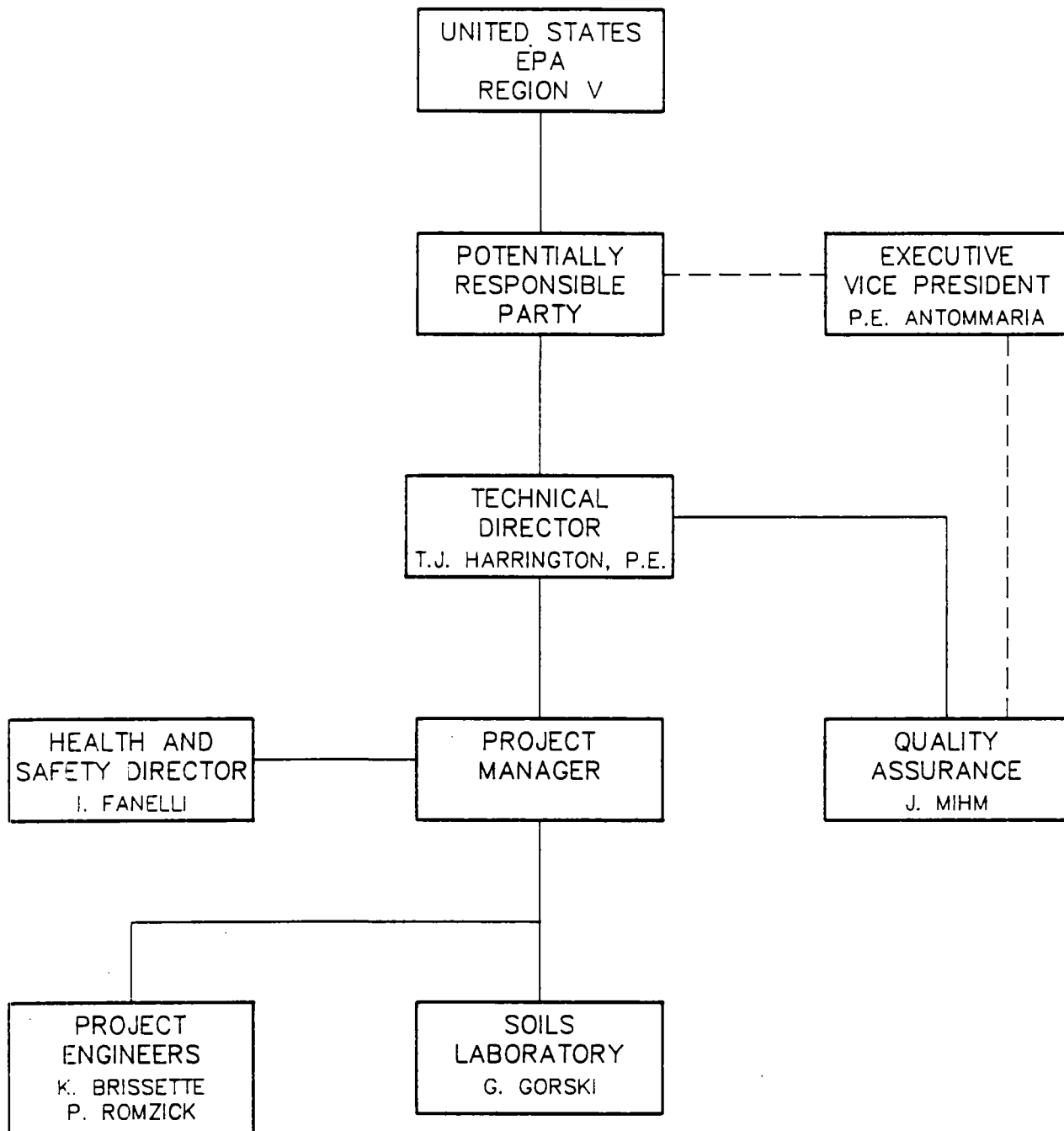
The Quality Assurance Coordinator will be responsible for documenting all notifications, recommendations, and final decisions. The Project Manager and the Quality Assurance Coordinator will be jointly responsible for notifying program staff and implementing the agreed upon course of action. The Quality Assurance Coordinator will be responsible for verifying the efficiency of the implemented actions. The development and implementation of preventative and corrective actions will be timed, to the extent possible, to minimize any adverse impact on project schedules and subsequent data generation/processing activities. However, scheduling delays will not override the decision to correct the data collection deficiencies or inaccuracies before proceeding with additional data collection. The Quality Assurance Coordinator will also be responsible for developing and implementing routine program controls to minimize the need for corrective action.

14.0 REPORTS TO MANAGEMENT

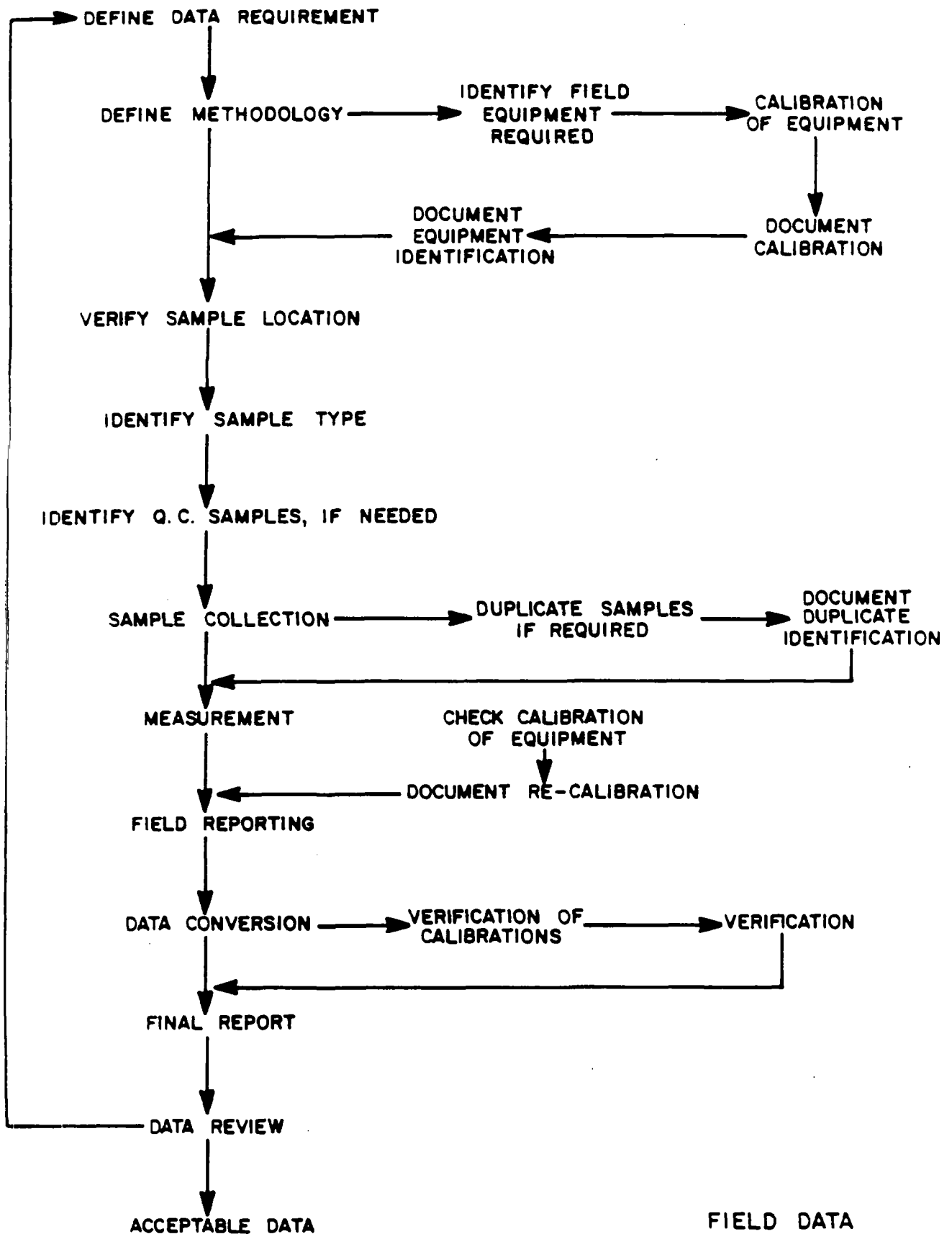
Periodic summary reports will be prepared to inform management of project status. The reports will include:

1. Periodic assessment of measurement data accuracy, precision, and completeness;
2. Results of performance audits and/or systems audits;
3. Significant Quality Assurance/Quality Control problems and recommended solutions;
4. Status of solutions to any problems previously identified.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the Quality Assurance Coordinator will prepare the reports to management. These reports will be addressed to the Project Manager and the Quality Review Team. The summary of findings shall be factual, concise, and complete. Any required supporting information will be appended to the report.



WORK PLAN
PROJECT MANAGEMENT TEAM
WAUKEGAN HARBOR SITE
FIGURE 1



FIELD DATA
COLLECTION AND VALIDATION
FIGURE 2

APPENDIX A
LABORATORY QUALITY ASSURANCE PROGRAM

CANONIE ENVIRONMENTAL
SERVICES CORPORATION

QUALITY ASSURANCE PROGRAM

Kenneth C. Wahl
Manager of Laboratory Services

Sharon K. Pierson
Quality Assurance Officer

September 1987

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1.0 INTRODUCTION

The purpose of the following Quality Assurance (QA) and Quality Control (QC) program is to ensure that the data generated by Canonie Environmental Services Corp., (Canonie) are accurate, precise, and, if necessary, will provide a sound legal background for any enforcement activities. The QA/QC program utilized by Canonie is based on EPA and CLP criteria.

The QA program is designed to ensure the reliability in the identification and measurement data. The QC program is designed to obtain prescribed standards of performance in the identification and measurement data. The above areas will be discussed in detail along with sampling, collection and preservation, sample control (log-in & storage), instrument calibration and maintenance, and analytical methodology.

2.0 LABORATORY PERSONNEL

The QA/QC program is not only the responsibility of the laboratory manager, organic and inorganic supervisors, and the QA officer, it is the responsibility of the entire Canonie Staff.

Canonie prides itself on the qualified personnel in its employ. As new personnel are hired, the same standards will apply. Personnel undergo a thorough and on-going training program, which includes going to seminars and training courses covering instrumentation, analytical methodology, and sampling techniques.

Weekly staff meetings are held to discuss new ideas, problems and their solution, and safety. Seminars are conducted periodically to allow everyone in the laboratory to become familiar in areas other than their expertise.

The laboratory staff at Canonie is made up of 30 experience chemist, biologist, and technical assistant. A brief review of Canonie's personnel is given. A more complete resume is available upon request.

Attachment I is the organizational chart for the laboratory. Each section has a section chief who is responsible for verifying all analytical work performed in that section. A quality assurance officer is responsible for the laboratory wide quality assurance program and directing corrective action as needed.

RESUMES

CANONIE ENVIRONMENTAL SERVICES CORP.

- Kenneth Wahl: Project Manager; M.S. and B.S. Chemistry, 15 years laboratory experience in the toxicology and environmental areas. Responsible for the overall daily operations of the laboratory.
- Jon Bartell: Project Supervisor; B.S. Biology/Chemistry, Masters Business Administration, 17 years of laboratory experience. Responsible for marketing analytical and engineering services. Proficient in all areas of the laboratory with varied sample types, including environmental and industrial processes.
- John Buerger: Project Supervisor; B.S. Chemistry/Biochemistry, Laboratory Operations Manager, 4 years Environmental Chemistry experience. Proficient in all areas of organic analyses, and computer automated systems.
- Jerry Martin: Project Scientist; GC/MS Supervisor; B.S. Environmental Science, 11 years laboratory experience, with 6 years GC/MS analysis and interpretation, including CLP samples and associated documentation.

- Roy Sloan: Project Scientist; Inorganic Supervisor; B.S. Chemistry, 10 years laboratory and supervisory experience. Proficient in AAS, ICP, ion chromatography, and wet chemical analyses. Experienced in developing and maintaining inorganic quality assurance programs.
- Sharon Pierson: Assistant Project Scientist; Quality Assurance Officer, B.S. Biology, 5 years laboratory experience, GC/MS Operator; 4 years in environmental laboratory. Experienced in GC purge and trap methods and Inorganic Chemistry. Also experienced in Worker Health and Safety, State and Federal Hazardous Waste Regulation.
- Arlen Neckels: Assistant Project Scientist; GC/MS VOA Operator; 23 years laboratory experience, 5 years in environmental laboratory. Experienced in GC, HPLC, AA, U.V. Spectrophotometry, Flame Photometry and Colorimetry.
- Michael Aseltine: Assistant Project Scientist; B.S. Biology, 4 1/2 years lab and field experience. Proficient in Gas Chromatograph, specialty area in Volatile Organic Analysis.
- Jack Shimasaki: Assistant Project Scientist; Inorganic Supervisor, A.B. Chemistry. Over 25 years of laboratory experience including analysis of agriculturally related products. Specialty in Inorganic Analysis.

Jim Hoch: Assistant Project Scientist; Pesticide/Herbicide Specialist, B.S. Chemistry, 6 years research lab experience. Proficient in Capillary GC, HPLC, IR, UV, and FT-NMR.

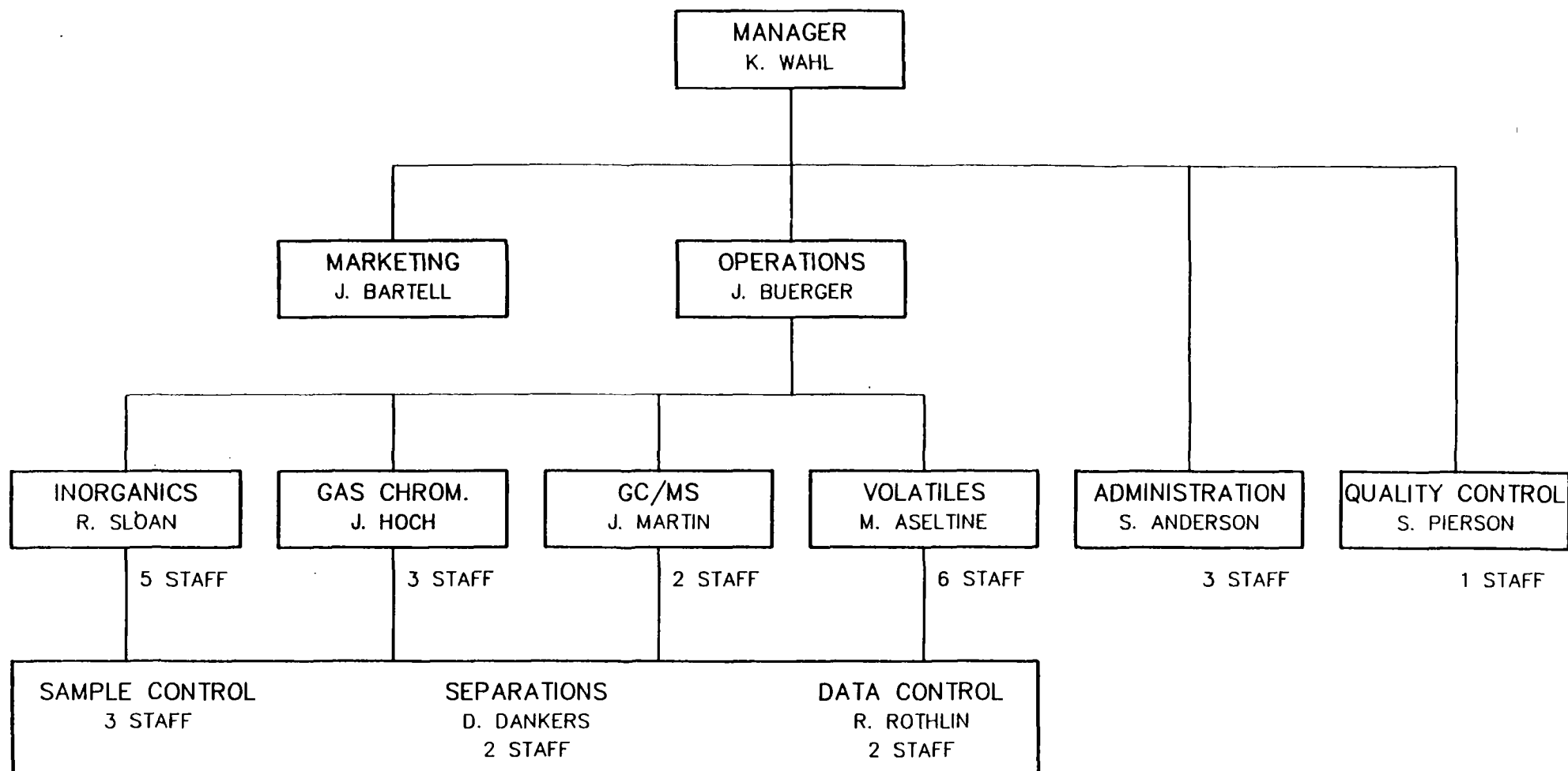
Donna Allsup: Chemist, Pesticide/Herbicide Specialist, B.S. Chemistry, Chemical Engineering (Drilling Fluids) 10 years laboratory experience, 5 years experience in marketing and management.

Dale Gimble: Chemist, Pesticide/Herbicide Specialist, B.S. Biochemistry, 4 years pesticide extraction experience, Gel Permeation Column experience, proficient in sample preparation and cleanup.

Gail Adams: Chemist; B.S. Forensic Sciences/Chemistry, 4 years Laboratory experience. Experienced in Volatile Organic Analysis and Inorganic Analysis. Proficient in all aspects of VOA analysis, start-up and operation of the purge and trap and GC system. Experienced in the operation of an AA.

Shakoora Azimi: Chemist; B.S. Chemistry and Biology, 3 years laboratory Experience in both inorganic preparation and all wet chemistry analysis. Proficient in all aspects of Volatile Organic Analysis and the operation of headspace analyzers, purge and trap systems, and gas chromatographs.

Mark Traxler: Chemist; B.S. Biochemistry, 7 years experience in Analytical chemistry, including 3 years with Canonie. Proficient in ICP, GFAAS, AA, IC, UV-VIS and all other instruments involved in inorganic analysis of soils, waters and hazardous wastes.



ADMINISTRATIVE ORGANIZATION
STOCKTON LABORATORY
ATTACHMENT I

CanonieEnvironmental

3.0 SAMPLING PROCEDURES

One of the most important things to keep in mind is that the information obtained from the analysis of a sample is only as good as the sample itself. The sample should be as close a representative of the actual site in question as possible.

Canonie Environmental Services Corp. provides its own sampling service upon request, using techniques in accordance to EPA's "Characterization of Hazardous Waste Sites-A, Methods Manual: Volume II, Available Sampling Methods" and "Standard Methods".

After sampling, the chemical and physical integrity of the sample must be maintained. Preservation of the sample is dependent upon the sample type and the required analysis. Usually keeping the sample on ice and sending it to the laboratory as soon as possible after sampling is sufficient.

Table I lists the recommended sampling, preservation procedure, container, and sample volume.

Table 1

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit
Acidity	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Potentiometry	305.2	1.0
Alkalinity	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Potentiometry	310.1	1.0
Ammonia	Grab or Composite	P,G	400	H2SO4 to pH <2	28 days	Spectrophotometry	SM 417B	0.1
BOD	Grab only	P,G	1000	Cool, 4 degrees, C	48 hours	Membrane Electracele	405.1	1.0
Bacteria	Grab only	P,G	200	Cool, 4 degrees C, 10% Na2S2O3, EDTA	6 hours	5 tube MPN	SM 908	2.2
Bicarbonate/Carbonate	Grab only	P,G	100	Determine onsite	No holding	Titrimetry	ASTM D513C	5.0
Boron	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Spectrophotometry	ASTM 3082	0.1
Bromide	Grab or Composite	P,G	100	None required	28 days	Spectrophotometry	320.1	1.0
COO	Grab only	P,G	50	H2SO4 to pH <2; Cool 4 degrees C	28 days	Digestion	410	10.
Calorimetry	Grab or Composite	P,G	100	Cool, 4 degrees C		Parr Bomb		
Carbon dioxide	Grab only	P,G	100	Cool, 4 degrees C	24 hours	Titrimetry	ASTM D513C	1.0
Chloride	Grab or Composite	P,G	50	None required	28 days	Titrimetry	325.3	1.0
Color	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Visual Comparison	110.2	1.0
Conductance	Grab or Composite	P,G	100	Cool, 4 degrees C	28 days	Conductivity, Meter	120.1	
Corrosivity	Grab or Composite	G	1000	Cool, 4 degrees C		Corrosivity toward Steel	1110	

Table 1 (cont.)

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit
Cyanide	Grab or Composite	P,G	500	NaOH to pH>12, 0.6g Ascorbic Acid	14 days	Distillation	9010	0.02
Fluoride	Grab or Composite	P	300	None Required	28 days	Specific Ion Electrode	340.2	0.1
Hardness	Grab or Composite	P,G	100	HNO3 to pH <2	6 months	Titrimetry	130.2	1.0
Hexavalent Chromium	Grab or Composite	P,G	100	Cool, 4 degrees C	24 hours	Spectrophotometry	SM 312.3	0.005
Hydroxide	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Titrimetry	ASTM D 514	1.0
Ignitability (Flash Point)	Grab or Composite	G	200	Cool, 4 degrees C		Closed Cap	1010	
Metals Suspended (except Cr VI)	Grab or Composite	P,G	1000	Filter onsite	6 months, except Hg—28 days	Atomic Absorption	200.	See pg 57-59
Metals, Dissolved (except Cr VI)	Grab or Composite	P,G	1000	Filter onsite, HNO3 to pH <2	6 months, except Hg—28 days	Atomic Absorption	200.	See pg 57-59
Metals, Total (except Cr VI)	Grab or Composite	P,G	1000	HNO3 to pH <2	6 months, except Hg—28 days	Atomic Absorption	200.	See pg 57-59
Nitrate	Grab or Composite	P,G	100	Cool, 4 degrees C H2SO4 to pH < 2	48 hours 28 days	Spectrophotometry	353.3	0.05
Nitrite	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Spectrophotometry	354.1	0.005
Nitrogen, Kjeldahl (total)	Grab or Composite	P,G	500	HNO3 to pH <2	28 days	Distillation, Titrimetry	351.3	0.1
Odor	Grab only	G	200	Cool, 4 degrees C	24 hours	Sensory Detection	140.1	1.0
Oil & Grease	Grab only	G	1000	Cool 4 degrees C H2SO4 to pH <2	28 days	Extraction, Gravimetry	413.1	1.0
Organic Compounds	Grab only	G	3000	Cool, 4 degrees C	7 days	Gas Chromatography	600 series	See pg 27-52

Table 1 (cont)

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit
Organic Lead	Grab or Composite	G	1000	Cool, 4 degrees C		MIBX Extraction		
Oxygen (dissolved)	Grab only	G	300	None	Analyze Immediately	Membrane Electrode	360.1	0.1
Percent Moisture	Grab or Composite	P,G	50 gms	Cool, 4 degrees C		Oven drying		
pH	Grab only	P,G	25	None	Analyze Immediately	pH Meter	150.1	—
Phosphates, Ortho	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Spectrophotometry	365.2	0.01
Phosphorus, Total	Grab or Composite	P,G	50	H2SO4 to pH <2	28 days	Spectrophotometry	365.4	0.01
Salinity	Grab or Composite	P,G	500	Cool, 4 degrees C	28 days	Hydrometer	SM 210 B	
Silica	Grab or Composite	P	50	Cool, 4 degrees C	28 days	Spectrophotometry	370.1	0.05
Solids Total Dissolved	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.1	1.0
Solids Total Settleable	Grab or Composite	P,G	1000	Cool, 4 degrees C	48 hours	Gravimetry	160.5	0.5
Solids Total	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.3	1.0
Solids Total Suspended	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.2	1.0
Specific Gravity	Grab only	P,G	100	None	28 days	Pycnometer	ASTM D1429	—
Sulfate	Grab or Composite	P,G	50	Cool, 4 degrees C	28 days	Nephelometry	375.4	1.0

Table 1 (Con't)

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit
Sulfide	Grab or Composite	P,G	500	Cool, 4 degree C, 2ml zinc acetate & NaOH	7 days	Titrimetry	376.1	1.0
Sulfite	Grab or Composite	P,G	50	Determine onsite	No holding	Titrimetry	377.1	2.0
Surfactants (MBAS)	Grab or Composite	P,G	250	Cool, 4 degrees C	48 hours	Extraction Spectrophotometry	425.1	0.05
Total Organic Carbon (TOC)	Grab or Composite	G, Teflon-lined cap	25	Cool, 4 degrees C HCl to pH <2	28 days	Combustion-Infrared	SM 505	1.0
Total Organic Halogens (TOX)	Grab or Composite	G, Amber Teflonline	100	Cool, 4 degrees C add 1ml 0.1M Na sulfite	7 days	TOX Instrumentation		
Tannins & Lignins	Grab or Composite	P,G	100	None	48 hours	Spectrophotometry	SM 513	0.1
Turbidity	Grab or Composite	P,G	100	Cool, 4 degrees C	48 hours	Nephelometry	180.1	0.01
Volatile Organics	Grab only	G	120	Cool, 4 degrees C	14 days	Gas Chromatography	601 and 602	See pg 27-29

4.0 SAMPLE CUSTODY

To meet the time constraints of each project and provide quality laboratory data requires careful coordination of the various laboratory activities. The main factors to be considered are: sample tracking from collection to the final report, sample preparation, and sample analysis time.

By notifying the laboratory prior to sampling will guarantee that:

1. By giving the laboratory prior notification of the number of samples and the sample matrix, the laboratory can schedule the work load accordingly.
2. Enough sample is taken to complete all testing.
3. The appropriate sample containers are used.

A. Notification of Analysis

1. A laboratory project number is assigned to the work requested. The number of samples are indicated on the project form, along with the sample matrix and the tests to be performed. Any other pertinent information that may assist in the handling of the samples is also noted. (See Attachment II.)

2. If sample containers are to be provided by Canonie, the bottle request section is filled out which indicates the number and type of container and where and when to send them. (See Attachment II.)
3. Along with the sample containers, a chain-of-custody form (Attachment III) and sample labels are included as a complete package.

B. Sampling

1. Collection and preservation of the sample in accordance to analysis protocol must be maintained.
2. All information on the sample label should be completed.
3. The sample origination should be noted so there is never any question regarding sample origin.
4. The chain-of-custody should reflect the identification of the sample to appear on the final report, this can be up to 20 characters per sample ID.
5. Any unusual observations noted or problems encountered during sampling should be noted on the chain-of-custody form.

C. Sample Receipt

1. When samples arrive at Canonie Environmental Services Corp., the chain-of-custody form and the samples are removed from the shipping container. At this time, the sample custodian checks to ensure that all the samples listed on the chain-of-custody are present and in good condition. The condition of the samples are recorded on the custody form.
2. Each sample container is given a unique six-digit laboratory ID number. The first number of the ID indicates the year in which the sample was received, i.e., samples received in 1986 begin with the number 6.
3. The sample custodian will then check to see if a laboratory project number has been assigned and that the initial work request matches the chain-of-custody analysis request.
4. The samples are then logged-in via computer which generates the sample tracking sheets (see Attachment IV) and the accession page (see Attachment V).
5. After completing all of the above, the appropriate section chief receives the complete project folder which includes:
 - a. A copy of the laboratory project work request form.
 - b. The chain-of-custody.
 - c. The sample tracking sheets.

Canon Environmental Analytical Laboratory
Client: _____
Billing Address: _____
Phone Number: _____

cc: _____

Project #: _____ LP #: _____
Quote #: _____
Client P. O. #: _____
Source: E.I.
Date Sampled: _____

Computer Login Information						Turn Around Time						Charge \$	Total
Date Rec'd	# of Samples	Matrix	Analysis Code	Analysis	Lab Sect.	Verbals Date Due	Init.	Lab Work Date Due	Init.	Report Out Date Due	Init.	Cost/ Sample	

Analysis Comments: _____

Bottle Shipping Request
Date Needed: _____ Date Shipped: _____ Init.: _____
Shipping: _____
Address: _____

Attention : _____
Phone Number: _____
Ship Via: _____

Container type	#	Container type	#

Comments: _____

Sampling - Pickup Charge		Charge	Total
Date Sampled:	Sampling Hours:		
Init.:	Total Miles:		
		Subtotal:	

Outside Laboratory Work						Cost/Sample	Total
Lab	Analysis	# Samples	Matrix	Date	Init.		
Comments: _____							

Miscellaneous Charge		Charge	Total
		GRAND TOTAL:	

RECEIVED FROM	DATE RECEIVED RECEIVER	COMMENTS		LABEL	LAB. NUMBER
		ANALYZED	DISPOSED		

SAMPLE CONTROL RECORD

REFRIGERATOR_____

[illegible]

1 = INITIAL STORAGE 2 = SAMPLE PREPARATION 3 = SAMPLE ANALYSIS 4 = DISPOSAL 5 = OTHER (INCLUDE BRIEF STATEMENT)

6. The samples are then placed in a refrigerator and maintained at 4°C, unless immediate analysis or preservation is required. Should the samples require any special preservation, the custodian contacts the appropriate chemist in order to properly preserve the samples. The preservation performed on the samples is noted on the chain-of-custody form.
7. The sample custodian is responsible for the removal of all samples from storage and for indicating the date they were removed in the sample control book (See Attachment VI).

D. Initiation of Analysis.

The Section Chief reviews the paperwork for accuracy and completeness then divides the work up according to analysis type. Each chemist is responsible for ensuring that samples are extracted according to analysis protocol and in a timely fashion to complete the work by the project due date.

5.0 CALIBRATION AND MAINTENANCE PROCEDURES

To assure the performance of the instruments used by Canonie Environmental Services Corp., records are kept on any maintenance done, both preventative and necessary. The record contains the date, worker, problems (if any), maintenance performed, and the results.

1. Gas and Liquid Chromatographs

The chromatographs are calibrated daily for each analysis to be performed. Calibration is done upon initial start-up and is rechecked periodically during the day depending on the number of samples run through the instrument. Calibration is done using a standard in the middle of the linear range for the instrument. As a general rule, after 10 samples are analyzed, the calibration curve is checked. Between calibrations, a QC sample is also monitored.

Initial calibration of the instrument is based on a five-point curve. Once linearity has been demonstrated, a three-point curve is routinely analyzed. From the initial calibration, an average response factor (conc./area) is determined from the five points. This response factor is compared to the response factor generated from the daily calibration. The daily response factor should be within $\pm 10\%$ of the average response factor; if it lies outside these limits a three-point curve is performed. If linearity is not achieved, then actions are taken to rectify the situation. Depending on the particular instrument and detector, a variety of routine maintenance is required.

2. GC/MS Calibration

Each GC/MS system must have the hardware tuned to meet the criteria listed in Exhibit E for a 50 ng injection of decafluorotriphenyl phosphine (DFTPP), for bromofluorobenzene (BFB). No sample analyses can begin until all these criteria are met. this criteria must be demonstrated each 12 hour shift. DEFTPP or BFB has to be injected to meet this criterion. Post-acquisition manipulation of abundances is not acceptable.

3. Atomic Absorption Spectrophotometer

The atomic absorption spectrophotometer is calibrated using a minimum of 3 standards and a blank for each parameter to be analyzed. After 10 samples have been tested, the intermediate standard is rechecked. As long as the value for the intermediate standard is within $\pm 10\%$ of the known value, analysis continues. If the instrument has drifted, it is recalibrated using 3 standards and the samples previously analyzed are checked against the new calibration curve.

For each analyte tested by atomic absorption spectrophotometer, the response factor (conc./abs.) for high and low levels are monitored. If the response factors deviate from the typical factors recorded, then a fresh standard is used. The physical adjustments are also checked, along with the lamp, and, in the case of graphite work, a new tube is put into operations. If this does not bring the response factor in line with those previously recorded, then maintenance is required.

4. Inductively Coupled Plasma Spectrometer

Calibration

Six solutions are used to calibrate and to verify the calibration of the ICP. These are (1) calibration blank solution (2) calibration standard solution, (3) initial calibration verification standard solution (4) interference check standard solution (5) linear check standard solution and (6) a quality control standard solution. The analytical curve is generated by the calibration blank and the calibration standard solution. After generation of the analytical curve, the initial calibration verification standard solution is analyzed. The recovery must be 90 to 110% of the expected value. The interference check standard is analyzed next. The recovery must be within a 40% window (80 to 120%). The linear check standard is then analyzed. The value of this standard is at two times the detection limit. Next a quality control standard is analyzed. The standard is usual from an outside source (EPA and/or ERA). The recovery of the standard must be within 90 to 110% of the expected value. If any of the above given criteria for any standard fails the problem must be corrected and the instrument recalibrated.

5. Analytical Balances

Daily or with each use, whichever is less frequent, a single class S-weight, near the typical weighing range, is weighed and recorded in a bound notebook. Should the weight deviate from the true value by 0.5%, the balance is inspected and checked to see that the pan is clear of any obstructions. The weight is checked on a different balance to verify if the S-weight is in error. If the weight passes the check, the balance must be inspected by a certified technician. Annually, the balances at Canonie Environmental Services Corp. are inspected and certified as to their accuracy.

6. Refrigerators

Since most of the samples received by the laboratory have required temperatures for preservation, it is imperative that the true operating temperature be known. Therefore, the daily temperature of the refrigerators are recorded in bound notebooks. Should the refrigerators not meet the required temperatures, corrective measures are taken.

7. Ovens

A daily temperature check is performed on ovens used for TSS and TDS analysis. Ovens not used for analysis purposes are monitored every 6 months to insure that the temperature range is accurate.

8. Thermometers

All thermometers used by Canonie Environmental Services Corp. are calibrated against an NBS certified thermometer. Each thermometer has a unique identification tag in order to monitor its performance. Annually, the thermometers are checked for their accuracy by submerging them in three different temperature baths. Thermometers found to deviate more than 1°C for a given range are used for noncritical work, or discarded.

9. pH Meters

Before using the pH meter, the probe is carefully examined for any physical damage. The pH meter is calibrated on a pH 7.0 buffer solution and a pH 4.0 or pH 10.0, depending on the range to be monitored. A log book is maintained for the pH meter.

10. Conductivity Meter

Before using the meter, closely inspect the condition of the electrode for any physical wear or damage. If the coating appears damaged, then the electrode should be replatinized according to manufacturer's guidelines.

Periodically, the conductivity cell is checked over a range of at least 5 concentrations of KCl listed in table 205.1 of the 16th edition of Standard Methods.

11. Turbidimeter

Daily or with each use, whichever is less frequent, a 4 NTU and a 40 NTU formazin standards are measured and recorded.

Periodically, the turbidimeter is calibrated according to the method described in Standard Methods, 16th edition, Section 214 a.

12. Repeating Pipets

Before delivering precise volumes, the pipets are checked for their accuracy by weighing water dispensed by five fill-and-dispense cycles. Based on the weight of the pure water, the mean dispensed volume can be determined for the pipet.

13. Glassware

Before using any glassware, check for any damage such as stars, cracks, or scratches. Laboratory glassware must be kept scrupulously clean to assure that there will be no contamination of samples or sample extracts. Depending on the eventual use of the glassware, several different cleaning methods are incorporated.

a. Volatile Organic Analysis (VOA)

Glassware used in VOA analysis are soaked in a tub of a cleaning solution containing no chlorines (Palmolive soap works well). The glassware is then washed in a sink using a fresh portion of the same detergent, then rinsed, first with tap water and then with organic pure water. The glassware is then transferred in to an oven and baked to ensure all volatile compounds are removed.

b. Organic Analysis

The glassware is first soaked in a dilute solution of Palmolive soap, rinsed, and then washed in a fresh soap solution. Next, a rinsing with tap water, followed by deionized water is performed. The glassware is placed on a drying rack until dry. They are then rinsed with acetone, allowed to dry, the exposed ends are wrapped with tin foil, and then put away for future use.

c. Inorganic Analysis

The glassware is first rinsed with a 1% solution of nitric acid. Next, they are washed using a phosphorous free detergent (Alconox), and rinsed once using tap water. The glassware is then rinsed using deionized water, followed by a 1% solution of nitric acid, and again with deionized water. They are then inverted on a rack until dry, and put in their proper storage area.

14. All Other Equipment

All other equipment is checked quarterly as to its general condition and for any physical damage. If any problems are noted, corrective actions are taken.

15. Instrument Log Book

All major instrumentation used at Canonie have an analysis log book. For every day that analysis is performed on the instrument, the log book is filled in with the sample analysis list. This includes blanks, calibration standard, QC work, and the sample ID's.

B. Preparation of Parent Solutions

When making up the parent solutions, a log book is maintained to record all the necessary information. A code number (prefixed with a "P") is assigned to the parent solution, the date it was made, analyst, code numbers of the standard and reagent used, all weights and volumes used are recorded on the Parent Solution Preparation Log. (See Attachment VIII). A balance check is also performed at the same time. All parent solution bottles are labeled with the code number, exact contents, date made, solvent, analyst, expiration date, and a mark on the side of the label to indicate the solvent line. Each time a significant aliquot is removed, a new mark is placed on the label. This is done in order to determine if evaporation has occurred.

C. Preparation of Stock Standards and Quality Control Stock

All compounds used in the preparation of stock standards or quality control stock by the laboratory are of a certified purity by the manufacturer.

A log book is maintained when preparing a stock solution. The date prepared, analyst, code numbers of all standards or parent solutions used, amounts added, final volume, solvent code number, etc. are entered into the log book. (See Attachment IX).

Commerically certified stock mixtures are also utilized by Canonie Environmental Services Corp. These stock mixtures are checked by analyzing quality assurance test samples obtained for the EPA or ERA.

D. General Storage

Proper storage of reference standards is an essential part of the analytical process.

When a container is removed from storage, it should be allowed to come to room temperature before opening. The bottle cap should remain off only long enough to withdraw the amount needed. After use, the bottle should be returned to storage immediately.

1. Purified Undiluted Standards

Place purified standards in a container, preferably with desiccant, and stored in an explosion proof refrigerator.

2. Concentrated "Stock" Solutions

- a. Stored at approximately 4°C.
- b. Replace stable compounds such as organochlorines and triazines after six months or when degradation is apparent.
- c. Replace compounds that degrade only at ambient temperatures after six months or when degradation is apparent.
- d. Monthly replacement for unstable compounds such as butylate, CEED, and disulfoton.
- e. Degradation studies are performed on DDT and Endrin in accordance to CLP protocol.

3. Dilute "Working" Solutions

- a. Store stable compounds in a refrigerator if not in daily use and reprepare by dilution of "stock" solution periodically. Replace sooner if solvent evaporation is evident.
- b. Stable solutions kept on lab benches should be replaced with fresh dilutions of "stock" after three months or with unopened standards from refrigerator storage. Replace sooner if solvent loss is evident.
- c. Compounds known to be unstable at ambient temperatures should be stored in a refrigerator between uses and replaced with fresh "stock" dilutions every two months. Replace sooner if solvent loss is evident.
- d. Unstable compounds should be stored in a refrigerator between used and replaced with fresh "stock" dilutions every week.

E. Solvent Monitoring

Solvents used for Organic analysis are checked for their purity by concentrating 200 mls to 1 ml and injecting it onto the instrument. Solvents showing interferences are not used for the analysis.

F. Deionized Water

Deionized water is produced on the premises. The resistivity is checked and recorded each time water is produced. Every three months the following tests are performed on the deionized water: pH, conductivity, silica content, total solids, and total organic carbon. The results from these tests are kept in a log book.

RECEIVING LOG FOR REAGENTS AND "AS IS" STANDARDS

[illegible]

STANDARD PREPARATION LOG

[illegible]

[illegible]

6.0 ANALYTICAL PROCEDURES

Canonie Environmental Services Corp. uses only analytical methods and procedures that are approved by the USEPA, or other agency to which the customer is responsible.

Most procedures utilized come directly from EPA/4-79-020 EPA "Methods for Chemical Analysis of Water and Wastewater," EPA SW-846 "Test Methods for Evaluating Solid Waste," and "Standard Methods for the Examination Water and Wastewater, 16th edition, 1985."

The following tables list the more common methods utilized for water and soils, along with the typical detection limits reported by Canonie:

Table II
Purgeable Halocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Bromodichloromethane	0.0005	0.02
Bromoform	0.0005	0.02
Bromomethane	0.0005	0.02
Carbon tetrachloride	0.0005	0.02
Chlorobenzene	0.0005	0.02
Chloroethane	0.0005	0.02
2-Chloroethylvinyl ether	0.0005	0.02
Chloroform	0.0005	0.02
Chloromethane	0.0005	0.02
Dibromochloromethane	0.0005	0.02
1,2-Dichlorobenzene	0.0005	0.02
1,3-Dichlorobenzene	0.0005	0.02
1,4-Dichlorobenzene	0.0005	0.02
Dichlorodifluoromethane	0.0005	0.02
1,1-Dichloroethane	0.0005	0.02
1,2-Dichloroethane	0.0005	0.02
1,1-Dichloroethene	0.0005	0.02
trans-1,2-Dichloroethene	0.0005	0.02
1,2-Dichloropropane	0.0005	0.02
cis-1,3-Dichloropropene	0.0005	0.02
trans-1,3-Dichloropropene	0.0005	0.02
1,1,2,2-Tetrachloroethane	0.0005	0.02
Tetrachloroethene	0.0005	0.02
1,1,1-Trichloroethane	0.0005	0.02
1,1,2-Trichloroethane	0.0005	0.02
Trichloroethene	0.0005	0.02
Trichlorofluoromethane	0.0005	0.02
Vinyl chloride	0.0005	0.02
Methylene chloride	0.0005	0.02

Table II
Purgeable Halocarbons

Other analytes available upon request

Freon

cis-1,2-Dichloroethene

EDB

Water

Analysis: Method 601

Sampling container: Specially prepared 40 ml volatiles vials, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 601, U. S. Environmental Protection Agency, Cincinnati, Ohio, July 1982.

Soil

Analysis: Method 8010

Sampling Container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods.

SW-846, Method 8010, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography.

Table II
Purgeable Aromatics

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Benzene	0.005	0.2
Chlorobenzene	0.005	0.2
1,2-Dichlorobenzene	0.005	0.2
1,3-Dichlorobenzene	0.005	0.2
1,4-Dichlorobenzene	0.005	0.2
Ethylbenzene	0.005	0.2
Toluene	0.005	0.2
Xylene	0.005	0.2

Other analytes available upon request

Acetone

Isopropyl Alcohol

Other Volatile Hydrocarbons (PID detector)

Other Volatile Hydrocarbons (FID detector)

Water

Analysis: Method 602

Sampling container: Specially prepared acidified 40 ml volatiles vials, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 602 and 624, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8020

Sampling container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8020, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography

Table II
Phenols

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
4-Chloro-3-methylphenol	0.001	10.
2-Chlorophenol	0.008	10.
2,4-Dichlorophenol	0.008	10.
2,4-Dimethylphenol	0.008	10.
2,4-Dinitrophenol	0.005	10.
2-Methyl-4,6-dinitrophenol	0.003	10.
2-Nitrophenol	0.005	10.
4-Nitrophenol	0.005	10.
Pentachlorophenol	0.005	10.
Phenol	0.008	10.
2,4,6-Trichlorophenol	0.001	10.

Other analytes available upon request
Tetrachlorophenol

Water

Analysis: Method 604

Sampling container: Specially prepared one liter bottle, taken in triplicate.

References: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 604, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Varian Liquid Chromatography Procedure #96, Determination of Trace Levels of Phenols in Water, Varian Instruments, Walnut Creek, California.

Soil

Analysis: Method 8040

Sampling container: Specially prepared mason jar or brass tube (200 g. required).

References: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8040, U. S. Environmental Protection Agency, 1982.
Varian Liquid Chromatography Procedure #96, Determination of Trace Levels of Phenols in Water, Varian Instruments, Walnut Creek, California.

Table II
Phenols

Shipping requirements: Packed in an iced cooler, with chain-of-custody.
Samples are extracted within 7 days and completely analyzed within 30 days of collection.
Method of analysis: Liquid and Gas Chromatography.

Table II
Organochlorine Pesticides

<u>Analyte</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
Aldrin	0.05	0.01
Alpha-BHC	0.05	0.01
Beta-BHC	0.05	0.01
Delta-BHC	0.05	0.01
Gamma-BHC	0.05	0.01
Chlordane	0.5	0.05
4,4'-DDD	0.05	0.01
4,4'-DDE	0.05	0.01
4,4'-DDT	0.05	0.01
Dieldrin	0.05	0.01
Endosulfan I	0.05	0.01
Endosulfan II	0.05	0.01
Endosulfan sulfate	0.05	0.01
Endrin	0.05	0.01
Endrin aldehyde	0.05	0.01
Heptachlor	0.05	0.01
Heptachlor epoxide	0.05	0.01
Toxaphene	5.	0.5
PCB-1016	0.5	0.01
PCB-1221	0.5	0.01
PCB-1232	0.5	0.01
PCB-1242	0.5	0.01
PCB-1248	0.5	0.01
PCB-1254	0.5	0.01
PCB-1260	0.5	0.01

Other analytes available upon request

DBCP

Methoxychlor

Table II
Organochlorine Pesticides

Water

Analysis: Method 608

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8080

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8080, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody. Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

Table II
PCB's (Polychlorinated Biphenyls)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
PCB-1016	0.5	0.05
PCB-1221	0.5	0.05
PCB-1232	0.5	0.05
PCB-1242	0.5	0.05
PCB-1248	0.5	0.05
PCB-1254	0.5	0.05
PCB-1260	0.5	0.05

Water

Analysis: Method 608.3

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, 1982.

Soil

Analysis: Method 8080.3

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8080, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody. Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

Table II
PCB'S in Oil

<u>Analytes</u>	<u>Detection Limits Oil (mg/kg)</u>
PCB-1016	5.
PCB-1221	5.
PCB-1232	5.
PCB-1242	5.
PCB-1248	5.
PCB-1254	5.
PCB-1260	5.

Oil

Analysis: Method PCB Oil

Sampling container: Two 20-40 ml Vials, teflon or foil lined cap (provide at-least 15 ml volume).

Reference: EPA Test Method for the Determination of Polychlorinated Biphenyls in Transformer Fluid and Waste Oils, EPA-600/4-81-045, U. S. Environmental Protection Agency, Cincinnati, OH, September 1982.

Shipping requirements: Securely packed in a leak proof container with chain-of-custody.

Acceptable holding time to analysis: 28 days.

Method of analysis: Gas Chromatography.

Table II
Polynuclear Aromatic Hydrocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Acenaphthene	0.01	1.
Acenaphthylene	0.01	1.
Anthracene	0.01	1.
Benzo (a) anthracene	0.01	1.
Benzo (a) pyrene	0.01	1.
Benzo (b) fluoranthene	0.01	1.
Benzo (g,h,i) perylene	0.01	1.
Benzo (k) fluoranthene	0.01	1.
Chrysene	0.01	1.
Dibenzo (a,h) anthracene	0.01	1.
Fluoranthene	0.01	1.
Fluorene	0.01	1.
Indeno (1,2,3-cd) pyrene	0.01	1.
Naphthalene	0.01	1.
Phenanthrene	0.01	1.
Pyrene	0.01	1.

Water

Analysis: Method 610

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 610, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8100

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8100, U. S. Environmental Protection Agency, 1982.

Table II
Polynuclear Aromatic Hydrocarbons

Shipping requirements: Packed in an iced cooler, with chain-of-custody.
Samples are extracted within 7 days and completely analyzed within 30 days of collection.
Method of analysis: Gas and Liquid Chromatography.

Table II
Chlorinated Hydrocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
2-Chloronaphthalene	0.001	0.1
1,2-Dichlorobenzene	0.0015	0.15
1,3-Dichlorobenzene	0.0015	0.15
1,4-Dichlorobenzene	0.0015	0.15
Hexachlorobenzene	0.0005	0.1
Hexachloroethane	0.0005	0.1
1,2,4-Trichlorobenzene	0.0005	0.1
Hexachlorocyclopentadiene	0.001	0.1
Hexachlorobutadiene	0.001	0.1

Water

Analysis: Method 612

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 612, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8120

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8120, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

Table II
Chlorinated Herbicides

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
2,4-D	0.02	0.02
2,4,5-TP	0.02	0.02

Other analytes available upon request

2,4,5-T
Dinoseb

Water

Analysis: Method 615

Sampling container: Specially prepared one liter sample bottles (amber), taken in triplicate.

Reference: Determination of Chlorinated Herbicides in Industrial and Municipal Wastewater, EPA-600/4-82-005, Method 615, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California.

Soil

Analysis: Method 8150

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8150, U. S. Environmental Protection Agency, 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California.

Shipping requirements: Packed in an iced cooler, with chain-of-custody. Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas and Liquid Chromatography.

Table II
Organophosphorus Pesticide

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
DEF	1.	1.
DeInav	1.	1.
Diazinon	1.	1.
Dimethoate	1.	1.
Disulfoton	1.	1.
Ethion	1.	1.
Ethyl parathion	1.	1.
Malathion	1.	1.
Methyl parathion	1.	1.
Methyl trithion	1.	1.
Phorate	1.	1.

Water

Analysis: Method 622

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Determination of Organophosphorus Pesticides in Industrial and Municipal Wastewater, EPA-600/4-82-008, Method 622, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8140

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8140, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 14 days of collection.

Method of analysis: Gas Chromatography.

Table II
Volatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
Benzene	0.005	0.125
Bromodichloromethane	0.005	0.125
Bromoform	0.005	0.125
Bromomethane	0.010	0.250
Carbon tetrachloride	0.005	0.125
Chlorobenzene	0.005	0.125
Chloroethane	0.010	0.250
2-Chloroethylvinyl ether	0.010	0.250
Chloroform	0.005	0.125
Chloromethane	0.010	0.250
Dibromochloromethane	0.005	0.125
1,2-Dichlorobenzene	0.005	0.125
1,3-Dichlorobenzene	0.005	0.125
1,4-Dichlorobenzene	0.005	0.125
Dichlorodifluoromethane	0.005	0.125
1,1-Dichloroethane	0.005	0.125
1,2-Dichloroethane	0.005	0.125
1,1-Dichloroethene	0.005	0.125
trans-1,2-Dichloroethene	0.005	0.125
1,2-dichloropropane	0.005	0.125
cis-1,3-Dichloropropene	0.005	0.125
trans-1,3-Dichloropropene	0.005	0.125
Ethylbenzene	0.005	0.125
Methylene chloride	0.005	0.125
1,1,2,2-Tetrachloroethane	0.005	0.125
Tetrachloroethene	0.005	0.125
Toluene	0.005	0.125
1,1,1-Trichloroethane	0.005	0.125
1,1,2-trichloroethane	0.005	0.125
Trichloroethene	0.005	0.125
Trichlorofluoromethane	0.005	0.125
Vinyl chloride	0.010	0.250

Table II
Volatile Organics (GC/MS)

Other analytes available upon request

Secondary Quantitation List (optional at extra charge), analytes and detection limits subject to change.

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l) (1)</u>	<u>Soil (mg.kg)(2)</u>
Freon 113	0.005	0.125
Acetone	0.005	0.125
Isopropyl Alcohol	0.005	0.125
Ethylene Dibromide (EDB)	0.005	0.125

Water

Analysis: Method 624

Sampling container: Specially prepared 40 ml volatile vial, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 624, U.S. Environmental Protection Agency, Cincinnati, OH, July 1982

Soil

Analysis: Method 8240

Sampling container: Air tight completely full brass tube.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8240, U.S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography/Mass Spec.

(1) Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable. Lower detection levels are possible with additional work at an increased price.

(2) Detection limits listed for soil/sediment are based on wet weight.

Table II
Semivolatile Organics (GC/MS)

Analytes	Detection Limits	
	Water (mg/l)(1)	Soil (mg/kg)(2)
Acenaphthene	0.010	0.330
Acenaphthylene	0.010	0.330
Aldrin	0.010	0.330
Anthracene	0.010	0.330
Benzo(a)anthracene	0.010	0.330
Benzo(b)fluoranthene	0.010	0.330
Benzo(k)fluoranthene	0.010	0.330
Benzo(ghi)perylene	0.010	0.330
Benzo(a)pyrene	0.010	0.330
Benzidine	0.040	1.32
Butyl benzyl phthalate	0.010	0.330
alpha-BHC	0.010	0.330
beta-BHC	0.010	0.330
delta-BH	0.010	0.330
gamma-BHC	0.010	0.330
Bis (2-chloroethoxy)methane	0.010	0.330
Bis (2-chloroethyl) ether	0.010	0.330
Bis (2-chloroisopropyl)ether	0.010	0.330
Bis (2-ethylhexyl)phthalate	0.010	0.330
4-Bromophenyl phenyl ether	0.010	0.330
Chlordane	0.100	3.30
4-Chloro-3-methylphenol	0.010	0.330
2-Choronaphthalene	0.010	0.330
2-Chlorophenol	0.010	0.330
4-Chlorophenyl phenyl ether	0.010	0.330
Chrysene	0.010	0.330
4,4'-DDD	0.010	0.330
4,4'-DDE	0.010	0.330
4,4'-DDT	0.010	0.330
Dibenzo(a,h)anthracene	0.010	0.330
Dibutyl phthalate	0.010	0.330
1,2-Dichlorobenzene	0.010	0.330
1,3-Dichlorobenzene	0.010	0.330

Table II
Semivolatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
1,4-Dichlorobenzene	0.010	0.330
3,3'-dichlorobenzidine	0.20	6.60
2,4-Dichlorophenol	0.010	0.330
Dieldrin	0.010	0.330
Diethylphthalate	0.010	0.330
2,4-Dimethylphenol	0.010	0.330
Dimethylphthalate	0.010	0.330
2,4-Dinitrophenol	0.050	1.65
2,4-Dinitrotoluene	0.010	0.330
2,6-Dinitrotoluene	0.010	0.330
Di-n-octylphthalate	0.010	0.330
Endosulfan I	0.010	0.330
Endosulfan II	0.010	0.330
Endosulfan sulfate	0.020	0.660
Endrin	0.010	0.330
Endrin aldehyde	0.020	0.660
Fluoranthene	0.010	0.330
Fluorene	0.010	0.330
Heptachlor	0.010	0.330
Heptachlor epoxide	0.010	0.330
Hexachlorobenzene	0.010	0.330
Hexachlorobutadiene	0.010	0.330
Hexachlorocyclopentadiene	0.010	0.330
Hexachloroethane	0.010	0.330
Indeno(1,2,3-cd)pyrene	0.010	0.330
Isophorone	0.010	0.330
2-Methyl-4,6-dinitrophenol	0.050	1.65
Naphthalene	0.010	0.330
Nitrobenzene	0.010	0.330
4-Nitrophenol	0.010	0.330
2-Nitrophenol	0.010	0.330
N-Nitrosodimethylamine	0.010	0.330
N-Nitrosodi-n-propylamine	0.010	0.330
N-Nitrosidiphenylamine	0.010	0.330

Table II
Semivolatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
PCB-1016	0.050	1.65
PCB-1221	0.050	1.65
PCB-1232	0.050	1.65
PCB-1242	0.050	1.65
PCB-1248	0.050	1.65
PCB-1254	0.050	1.65
PCB-1260	0.050	1.65
Pentachlorophenol	0.050	1.65
Phenanthrene	0.010	0.330
Phenol	0.010	0.330
Pyrene	0.010	0.330
Toxaphene	0.5	16.5
1,2,4-Trichlorobenzene	0.010	0.330
2,4,6-Trichlorophenol	0.010	0.330

Water

Analysis: Method 625

Sampling container: Specially prepared one liter bottle taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201796, Method 625, U.S. Environmental Protection Agency, Cincinnati, OH, July 1982

Soil

Analysis: Method 8270

Sampling container: Specially prepared mason jar, 200 g soil required.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8270, U.S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler with chain-of-custody. Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: GC/MS

Table II
Semivolatile Organics (GC/MS)

- (1) Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable. Lower detection levels are possible with additional work at an increased price.
- (2) Detection limits listed for soil/sediment are based on wet weight.

Table II
Carbamates

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Aldicarb	0.05	1.
Carbaryl	0.05	1.
Carbofuran	0.05	1.
Diuron	0.05	1.
Linuron	0.05	1.
Methomyl	0.05	1.
Oxamyl	0.05	1.

Water

Analysis: Method 632

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method of Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 632, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 632Mod

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Modified Method 632 Test Method for Evaluating Solid Waste, Physical/Chemical Methods, adapted for soil.

Shipping requirements: Packed in an iced cooler, with chain-of-custody. Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Liquid Chromatography.

Table II
Fumigants

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
DBCP (Dibromochloropropane)	0.01	1.0
EDB (Ethylene Dibromide)	0.1	1.0

Water

Analysis: Method 2000

Sampling container: Specially prepared one liter sample bottles, taken in triplicate, for EDB only, use 40 ml vial (purge & trap technique).

Reference: Analysis of 1,2-dibrom -3- chloropropane in Water, California Department of Health Services Methods, p. 215.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial wastewater, PB83-201798, Method 601, U. S. Environmental Protection Agency, Cincinnati, Ohio, July 1982 (EDB only).

Soil: Method 2010

Sampling container: Air tight completely full brass tube.

Reference: Analysis of 1,2-dibrom -3- chloropropane in Water, California Department of Health Services Methods, p. 215.

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8010, U. S. Environmental Protection Agency, 1982 (EDB only).

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection. EDB only using purge & trap technique, 14 days to analysis.

Method of analysis: Gas Chromatography.

Table II
Benzene, Toluene, Xylene
(Gasoline components)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Benzene	0.005	0.2
Xylene	0.005	0.2
Toluene	0.005	0.2
Other Hydrocarbons	0.005	0.2

Other analytes available upon request
EDB

Water

Analysis: Method 2500

Sampling container: Specially prepared acidified 40 ml volatiles vials, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 602, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 2510

Sampling container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8020, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography with FID detector.

Table II
Total Extractable Hydrocarbons
(Diesel/Fuel Oil Components)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Total Extractable Hydrocarbons	1.	10.

Water

Analysis: Method 2515

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 602 modified, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 2520

Sampling container: Air tight completely full brass tube or 40 ml vial

Reference: Analytical Procedures for the Detection and Quantitation of Total Petroleum Fuel Hydrocarbons and Fuel Constituents California Regional Water Quality Control Board, 11/8/1985.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Solvent extraction, Gas Chromatography with FID detector.

Table II
EP Toxicity Pesticides

<u>Analytes</u>	<u>Maximum Contaminant Level</u> (mg/l leachate)	<u>Detection Limit</u>
Endrin	0.02	All detection limit are one-tenth or less of the maximum contaminant level
Lindane	0.4	
Methoxychlor	10.0	
Toxaphene	0.5	
2,4-D	10.0	
2,4,5-TP	1.0	

Analysis: Method EPTP

Samples are extracted with acetic acid and the leachate is examined for the pesticides listed.

Sampling container: Specially cleaned mason jars for solids and sludges sample size 400 g, and liter containers for liquids.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, EP Toxicity, U. S. Environmental Protection Agency, 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days collection.

Method of analysis: Gas and Liquid Chromatography.

Table II
Title 22 Pesticides/Herbicides

<u>Analytes</u>	<u>Detection Limit Water (mg/l)</u>
Endrin	0.00005
Lindane	0.00005
Methoxychlor	0.001
Toxaphene	0.005
2,4-D	0.01
2,4,5-TP (Silvex)	0.001

Water

Analysis: Method T22P

Sampling container: Specially prepared one liter bottles taken in triplicate.
Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982. Determination of Chlorinated Herbicides in Industrial and Municipal Wastewater, EPA-600/4-82-005, Method 615, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.
Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

Table II
Priority Pollutant Metals
Metals

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Antimony	0.02	5.
Arsenic	0.01	5.
Beryllium	0.005	0.75
Cadmium	0.005	1.
Chromium	0.005	5.
Copper	0.05	5.
Lead	0.005	5.
Mercury	0.001	0.2
Nickel	0.05	5.
Selenium	0.005	1.
Silver	0.01	5.
Thallium	0.01	5.
Zinc	0.01	5.

Samples are digested and analyzed for the 13 metals, according to EPA criteria, Federal Register, December 3, 1979.

Sampling container: Special acid-washed mason jars for solids and sludges sample size 400 g, and special acid-washed liter containers for liquids.

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Individual Metals Analysis, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

Table II
California Assessment Manual Metals
Regulatory Limits

Detection Limits

<u>Analytes</u> <u>(mg/l)</u>	<u>TTLc (mg/kg)</u>	<u>STLC (mg/l)</u>	<u>TTLc (mg/kg)</u>	<u>STLC</u>
Arsenic	500	5	5.	0.1
Antimony	500	15	5.	0.1
Barium	10,000	100	5.	0.1
Beryllium	75	0.75	0.75	0.1
Cadmium	100	1	1.	0.1
Chromium III/VI*	2,500/500	560/5	5/5	0.1/0.1
Cobalt	8,000	80	5.	0.1
Copper	2,500	25	5.	0.1
Lead	1,000	5	5.	0.1
Mercury	20	0.2	0.2	0.1
Molybdenum	3,500	350	5.	0.1
Nickel	2,000	20	5.	0.1
Selenium	100	1	1.	0.1
Silver	500	5	5.	0.1
Thallium	700	7	5.	0.1
Vanadium	2,400	24	5.	0.1
Zinc	5,000	250	5.	0.1

Samples are either acid digested for total metal content (to be compared to TTLc regulatory values) or extracted with citrate buffer (to be compared to STLC regulatory values).

*Chromium values are reported as total chromium, the sum of the III and VI species.

Sampling container: Special acid-washed mason jars for solids and sludges (400 g sample size), and special acid-washed liter containers for liquids.

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Individual Metals Analysis as per, U. S. Environmental Protection Agency, Methods listed on pp. 28, 30.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

Table II
EP Toxicity Metals

<u>Analytes</u>	<u>Maximum Contaminant Level</u> (mg/l leachate)	<u>Detection Limit</u>
Arsenic	5.0	0.1
Barium	100.0	0.1
Cadmium	1.0	0.1
Chromium (total)	5.0	0.1
Mercury	0.2	0.1
Lead	5.0	0.1
Selenium	1.0	0.1
Silver	5.0	0.1

Samples are extracted with acetic acid, and the leachate is examined for the eight metals listed.

Sampling container: Specially cleaned mason jars for solids and sludges, and liter containers for liquids.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, EP Toxicity, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

Table II
EPA Methods
Atomic Absorption Analysis
Metals in Water

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>	<u>ICP</u>
Aluminum	EPA 202.1	EPA 202.2			EPA 200.7
Antimony	EPA 204.1	EPA 204.2			EPA 200.7
Arsenic		EPA 206.2	EPA 206.3		
Barium	EPA 208.1	EPA 208.2			EPA 200.7
Beryllium	EPA 210.1	EPA 210.2			EPA 200.7
Cadmium	EPA 213.1	EPA 213.2			EPA 200.7
Calcium	EPA 215.1				EPA 200.7
Chromium (Total)	EPA 218.1	EPA 218.2			EPA 200.7
Cobalt	EPA 219.1	EPA 219.2			EPA 200.7
Copper	EPA 220.1	EPA 220.2			EPA 200.7
Iron	EPA 236.1	EPA 236.2			EPA 200.7
Lead	EPA 239.1	EPA 239.2			EPA 200.7
Magnesium	EPA 242.1				EPA 200.7
Manganese	EPA 243.1	EPA 243.2			EPA 200.7
Mercury				EPA 245.1	
Molybdenum	EPA 246.1	EPA 246.2			EPA 200.7
Nickel	EPA 249.1	EPA 249.2			EPA 200.7
Potassium	EPA 258.1				EPA 200.7
Selenium		EPA 270.2	EPA 270.3		
Silver	EPA 272.1	EPA 272.2			EPA 200.7
Sodium	EPA 273.1				EPA 200.7
Strontium*	303A				EPA 200.7
Thallium	EPA 279.1	EPA 279.2			EPA 200.7
Vanadium	EPA 286.1	EPA 286.2			EPA 200.7
Zinc	EPA 289.1	EPA 289.2			EPA 200.7

Reference: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, EMSL, U. S. Environmental Protection Agency, 1979.

* Reference: Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985.

Method of Analysis: Atomic Absorption Spectrophotometry.

Table II
Minimum Detection Limits
Atomic Absorption Analysis
Metals in Water
mg/l

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum	0.5	0.02		
Antimony	0.02	0.005	0.005	
Arsenic		0.01	0.003	
Barium	0.2	0.05		
Beryllium	0.04	0.0005		
Cadmium	0.02	0.0005		
Calcium	0.05			
Chromium (Total)	0.1	0.003		
Cobalt	0.05	0.005		
Copper	0.05	0.003		
Iron	0.05	0.01		
Lead	0.4	0.002		
Magnesium	0.02	0.001		
Manganese	0.01			
Mercury				0.001
Molybdenum	0.1	0.005		
Nickel	0.2	0.005		
Potassium	0.05			
Selenium		0.005	0.004	
Silver	0.02	0.001		
Sodium	0.05			
Strontium	0.02	0.002		
Thallium	0.1	0.003		
Vanadium	0.5	0.005		
Zinc	0.03	0.005		

Table II
EPA Methods
Atomic Absorption Analysis
Metals in Soil

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum				
Antimony	EPA 7040	EPA 7041		
Arsenic		EPA 7060	EPA 7061	
Barium	EPA 7080	EPA 7081		
Beryllium	EPA 7090	EPA 7091		
Cadmium	EPA 7130	EPA 7131		
Calcium				
Chromium (Total)	EPA 7190	EPA 7191		
Cobalt				
Copper	EPA 7210	EPA 7211		
Iron	EPA 7380	EPA 7381		
Lead	EPA 7420	EPA 7421		
Magnesium				
Manganese	EPA 7460	EPA 7461		
Mercury				EPA 7471
Molybdenum				
Nickel	EPA 7520	EPA 7521		
Potassium				
Selenium		EPA 7740	EPA 7741	
Silver	EPA 7760	EPA 7761		
Sodium	EPA 7770			
Strontium				
Thallium	EPA 7840	EPA 7841		
Vanadium	EPA 7910	EPA 7911		
Zinc	EPA 7950	EPA 7951		

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.

Method of analysis: Atomic Absorption Spectrophotometry.

Table II
Minimum Detection Limits
Atomic Absorption Analysis
Metals in Soil
mg/kg

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum	50.	2.		
Antimony	20.	1.	1.	
Arsenic		1.	0.5	
Barium	20.	5.		
Beryllium	20.	0.5		
Cadmium	4.	0.5		
Calcium	20.			
Chromium (Total)	20.	0.5		
Cobalt	20.	0.5		
Copper	20.	0.5		
Iron	20.	1.		
Lead	40.	0.5		
Magnesium	20.			
Manganese	4.	0.2		
Mercury				0.2
Molybdenum	40.	0.5		
Nickel	20.	0.5		
Potassium	20.			
Selenium		1.	1.	
Silver	4.	0.2		
Sodium	20.			
Strontium	4.	0.2		
Thallium	20.	0.5		
Vanadium	80.	0.5		
Zinc	5.	0.5		

7.0 DATA REVIEW AND REPORTING

All of the data generated by Canonie Environmental Services Corp. are reviewed by at least two chemists from each of the various areas. If a second chemist is unavailable to review the work, then the quality assurance officer will do the second review. The quality assurance officer randomly reviews work from each section to verify the documentation and reported results.

The following areas are checked when reviewing the work:

1. That the calculations, identification, and reported units are correct.
2. That all the results obtained for the samples were within the working calibration range or were diluted into the working calibration range.
3. The QC results meet acceptance criteria.

If the data and QC results are unacceptable, then the cause for the results being unacceptable must be determined before the analysis can continue and results can be released. In the event that the QC results fall outside of the control limits, a QA/QC comment sheet (see Attachment X) is issued, on which the section head, analyst, and the QA Officer make appropriate comments and sign.

If the data and the QC results are acceptable, the chemist initials the tracking sheets, bench sheets, and/or other generated data, and gives the entire data package to a second chemist for review and approval.

Once all of the various areas of analysis are completed, the entire report is reviewed by the Laboratory Supervisor to insure that all information, data, and resulting conclusions for a particular project are properly documented, statistically valid, and meet the requirements of the client.

After approving the entire project, a typed report is generated, proofread by an administrator, signed by each analyst and each chemist who reviewed the work, and then sent to the customer and, if necessary, any County, State, or Federal agencies.

The original report then goes to the Accounting Department for posting, and eventually filed by customer.

CANONIE ENVIRONMENTAL

QA/QC COMMENT SHEET

METHOD _____

DATE ANALYZED _____

INSTRUMENT ID _____

LP NUMBER _____

ANALYST _____

CLIENT _____

PROBLEM: _____

CORRECTIVE ACTIONS: _____

SECTION CHIEF _____ DATE _____

ANALYST _____ DATE _____

COMMENTS _____

QA/QC DEPT. _____ DATE _____

COMMENTS: _____

8.0 QUALITY CONTROL

The quality control program is the most essential element to determining the performance of the analytical measurements.

The quality control program involves the analysis of a blank, duplicate, and spiked sample with every set of ten samples or with each matrix type.

1. Analysis of Blank

There are several different types of blanks that can be prepared and analyzed; reagent blank, travel blank, or field blank.

- a. A reagent blank is prepared using deionized water, purified soil, solvents, acids, or other reagents used in the preparation and analysis of the samples. All analyses are run using a reagent blank in order to verify that any positive results are not due to contamination from the laboratory. Blanks showing contamination above minimal detectable levels indicates process contamination that must be corrected.

- b. A travel blank is prepared by Canonie Environmental Services Corp. and transported to the field, along with the sample containers. The travel blank undergoes all of the same handling as a sample, e.g., placed in the same cooler at the time of sampling, thus showing if any contamination was picked up during transportation. Travel blanks will be used to assess the environment in which the bottles and samples underwent during transportation. The results from the travel blank are used to assess contamination encountered during transportation. Should contamination occur, corrective measures must be taken (i.e., monitoring, resampling).
- c. A field blank is prepared at the sampling site and returned blind to the laboratory with the sample. The field blank is exposed to the same environmental factors as the samples and is a good test to see if contamination is picked up at the time of sampling. Field blanks are used to monitor sampling techniques and are usually analyzed as a blind QC sample.

2. Analysis of Duplicates

The preferred method of duplication at Canonie Environmental Services Corp. is the analysis of a duplicate spike sample. A sample is chosen randomly, divided into equal aliquots, spiked with a known amount of the analyte and prepared for analysis. Duplicate samples are analyzed to determine the precision of the preparation and analytical techniques. Daily the relative percent difference (RPD) between the spike and duplicate spike are plotted (See attachment XI). Relative percent difference is calculated as:

$$\text{RPD} = \frac{\text{Amount in Spike 1} - \text{Amount in Spike 2}}{\frac{\text{Spike 1} + \text{Spike 2}}{2}} \times 100$$

3. Analysis of Spiked Samples

In order to assure the accuracy of the analytical procedure, a sample is randomly chosen and spiked with a known amount of the analyte to be tested. The increased value for a spiked sample resulting from the addition of the analyte at a known concentration compared to the value obtained for that same analyte in the unspiked sample determines the percent recovery.

Daily, control charts are plotted and kept by instrument specific, matrix specific, and analyte specific (see Attachment XII). The percent recovery for a spike sample is calculated as follows:

$$\% \text{ Rec.} = \frac{\text{Amt. Found in Spiked Sample} - \text{Amt. Found in Sample}}{\text{Known Amount Added}} \times 100$$

4. Measurement of Method Detection Limits

Periodically, Canonie Environmental Services Corp. reevaluates its method detection limits (MDL) for each matrix type and for each method.

To determine the MDL, the methods prescribed by the EPA are employed. The MDL is defined as the minimum concentration of a substance that can be identified, measured, and reported with 99% confidence.

a. Procedure

1. If the MDL is determined in water, a laboratory standard at a concentration 1 - 5 times that of the estimated MDL is analyzed.

2. For other matrices: a standard 5 - 10 times that of the estimated MDL is analyzed.
3. The standard is analyzed seven times.
4. The MDL is calculated by finding the standard deviation of the results for all seven analyses and multiplying the standard deviation by a factor of 3.143.

CanonieEnvironmental

R. P. D.

ANALYTE _____

LAB I.D.																		
DATE																		
OBS. VALUE																		
DUP. VALUE																		
R. P. D.																		

20

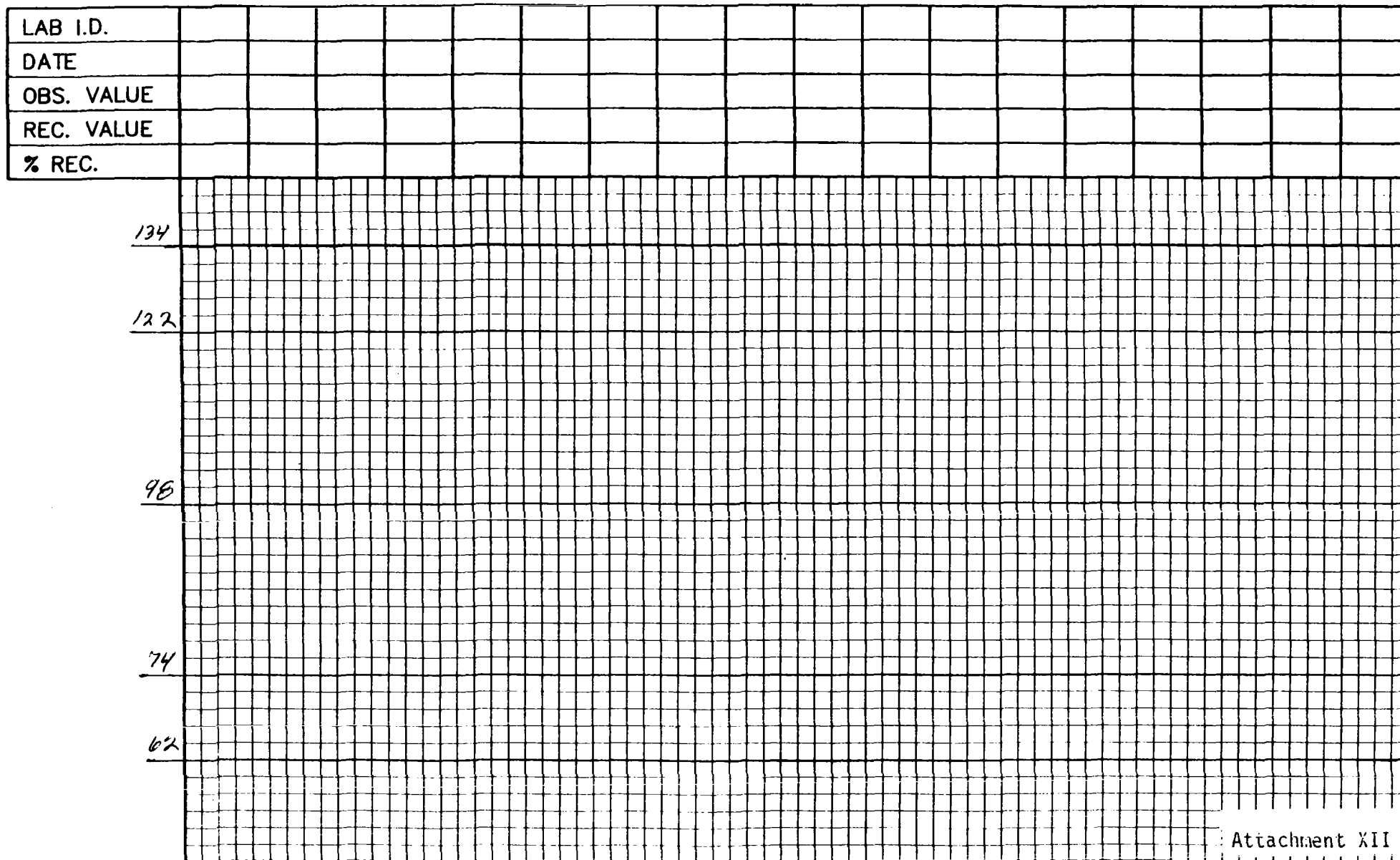
15

10

5

CONTROL CHART

ANALYTE O,P-XYLENE

UCL 134 UWL 122 AVE. 96 LWL 74 LCL 62 STD. DEV. 12


9.0 ESTABLISHMENT OF ACCEPTABLE LIMITS

Construction of a Control Chart or \bar{X} Chart

A control chart is constructed on data produced in the laboratory for a specific analysis and instrument. It is a method of showing the precision of an analysis, based on common, simple statistical methods.

When a quality control sample of known concentration is analyzed a number of times, a series of analytical results are received which should bracket the known concentration in a Gaussian or normal distribution. The average (\bar{X}) is the sum of the results divided by the number of results.

$$\bar{X} = \frac{\sum x}{n}$$

The standard deviation (σ) is an indication of the spread of the results from the mean, or the precision of the analysis. This is defined as the square root of the sum of the differences between the average and each result, squared, divided by one less than the number of analysis.

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

The proportion of results lying within any given range is related to the standard deviation. That is, 68% of the observations lie within $\bar{X} \pm 1\sigma$, 95% between $\bar{X} \pm 2\sigma$, and 99% between $\bar{X} \pm 3\sigma$, for large numbers of samples. This relationship becomes more precise as n increases, but is suitable for smaller populations (approximately 20).

Once a quality control sample has been analyzed at least 20 times and the mean and standard deviation established, it is possible to predict the limits into which any further analysis of the sample will fall if the analysis is performed under identical conditions. For example, if a known QC sample is 10.0 ppb, the analysis may produce an \bar{X} of 9.9 and of 1.0 for 20 results. Then 95% of the results of re-analysis will fall within 9.9 ± 2.0 or from 7.9 to 11.9. In like manner 99% of the results of reanalysis will fall within 9.9 ± 3.0 , or from 6.9 to 12.9. These ranges are known as limits. The upper and lower warning limits are $\bar{X} \pm 2$, and the upper and lower control limits are $\bar{X} \pm 3$.

These limits can be used to construct a chart defining when an analysis is "in control." (See Attachment XII)

In order to construct a control chart, the following steps are necessary:

1. Analyze the quality control sample at least 20 times.
2. Collate the results, finding the average (\bar{X}) and the standard deviation ().
3. Set the upper warning limit at $\bar{X} + 2$, the lower warning limit at $\bar{X} - 2$.
4. Set the upper control limit at $\bar{X} + 3$ and the lower control limit at $\bar{X} - 3$.
5. Draw a control chart which delineates the average and the four limits.
6. Plot each subsequent quality control result on the chart to demonstrate the precision of that analysis. (See Attachment XII).

10.0 ACCEPTANCE CRITERIA AND PROBLEMS

When an analysis is being performed, the analyst must verify immediately that the results generated for the quality control samples falls within the acceptance limits for that analysis.

The quality control sample indicates acceptable analysis values when it falls between the lower warning limit (LWL) and the upper warning limit (UWL). As long as the quality control sample falls within these limits the analysis will continue and results will be released to the client. If the quality control sample value falls between the control limit and warning limit (UCL and UWL or LCL and LWL), the analysis should be scrutinized as possibly out-of-control. The sample results are still acceptable at this point, however, if the control sample value remains between the control limit and warning limit for 5 consecutive days, the analysis is stopped and no data is released until the problem is resolved.

If the quality control sample value falls outside the control limits (UCL or LCL), this indicates an out-of-control situation. The analysis is stopped and no data is released until the reason for the problem has been identified and resolved. When an out-of-control situation occurs, the analyst is required to fill out a QA/QC comment sheet (see Attachment XIII) and submit it to both their immediate supervisor and the Quality Assurance Officer. After the problem has been corrected and shown that acceptable results are once again produced, samples will once again be analyzed and data will be released. Depending on the type of problem encountered, the problem and its solution will be documented.

Not only are the control charts used to monitor the performance of the laboratory, the Quality Assurance Officer also monitors the laboratory performance by releasing blind quality assurance samples and by randomly reviewing particular analysis. In the event that the Quality Assurance Officer spots unacceptable practices, a formal notice (see Attachment XIII) is issued to the laboratory manager and the section supervisor in which the corrective actions must be implemented. The section supervisor must respond to the formal notice and correct any deficiencies.

Precision, Accuracy and Relative Error:

Precision refers to the reproducibility of a method when it is repeated on a homogeneous sample under controlled conditions.

The precision or reproducibility of a method shall be expressed as a percentage of the mean and is termed the relative standard deviation or coefficient of variation:

$$C_v = \frac{100}{X}$$

where C_v = Relative standard deviation or coefficient of variation
= standard deviation
X = mean

Relative error expresses the difference between the measured and the actual amounts:

$$\text{relative error} = \frac{X - TV}{X}$$

where
X = observed value
TV = true value
X = mean

Therefore, relative error represents the measure of accuracy of a method.

CANONIE ENVIRONMENTAL

QA/QC COMMENT SHEET

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CLIENT _____

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CORRECTIVE ACTIONS: _____

SECTION CHIEF _____ DATE _____

ANALYST _____ DATE _____

COMMENTS _____

QA/QC DEPT. _____ DATE _____

COMMENTS: _____

11.0 PERFORMED AND SYSTEM AUDITS

Canonie Environmental Services Laboratory routinely analyzes performance audit samples from both New York State Department of Health for potable and non-potable water and US EPA for both the drinking water (WS series) and wastewater (WP series) samples.

Certified reference materials are purchased from the National Bureau of Standards for metals in sediment like matrixs. Additional reference material is acquired from the US EPA Quality Assurance Materials Book.

3. Current laboratory certification include:

1. California DOHS certification for the analysis of Hazardous Waste.
2. California Department of Health Service, Sanitation and Radiation, approved water laboratory certification for General Chemical and Organic Chemical.
3. New York State Department of Health certification for potable water and non-potable water analysis.

12.0 REVIEW OF ANALYTICAL RESULTS BY THE QUALITY ASSURANCE OFFICER

The function of the Quality Assurance Officer is to assure that the quality of the service delivered to the client meets the highest possible standard of quality, through the control of handling and analytical procedures performed on the samples. Should the acquired data be of suspect quality, it is the duty of the Quality Assurance Officer to halt its release.

Outlined is the functions and responsibilities performed by the Quality Assurance Officer:

1. Coordinate proficiency testing for laboratory approval programs.
2. Coordinate any on-site QA/QC inspections.
3. Prepare and update QA/QC plans.
4. Assist in the development of new analytical methods and techniques.
5. Assist in the development and planning of QA/QC documents and programs with the Project Engineer on a project by project basis.
6. With the QC committee continue to develop and implement a QC program.

7. Monitor the sections for compliance to the QA/QC program by:
 - reviewing standard storage and preparation
 - reviewing instrument log books
 - reviewing QC documentation for completeness
 - reviewing sample storage
8. Analyze data generated from in-house QC check samples.
9. Advise personnel on laboratory procedures.
10. Advise personnel when problems are encountered with an analysis.
11. Respond to inquiries made regarding laboratory QA/QC related activities.

RESPONSIBILITIES: The Quality Assurance Officer will:

1. Identify and refer any instances in which QC objectives are not being met to the section heads and laboratory manager for remedial actions.
2. Assure that suspect data are not included in laboratory reports.

3. Follow up on the remedial actions undertaken in response to the above referrals to assure that QC objectives are once again being met.
4. Inspect corrective action reports for out-of-control events.
5. Prepare a monthly QA report summarizing any warning sheets issued, corrective actions taken, unresolved problems, and overall QC activities of the laboratory.

A monthly QA report is then submitted to the Manager of Laboratory Services, Ken Wahl. He reviews the progress of the laboratory, makes his recommendations and goals for the next month. The monthly QA report is submitted to the Executive Vice President, Phillip E. Antommaria.